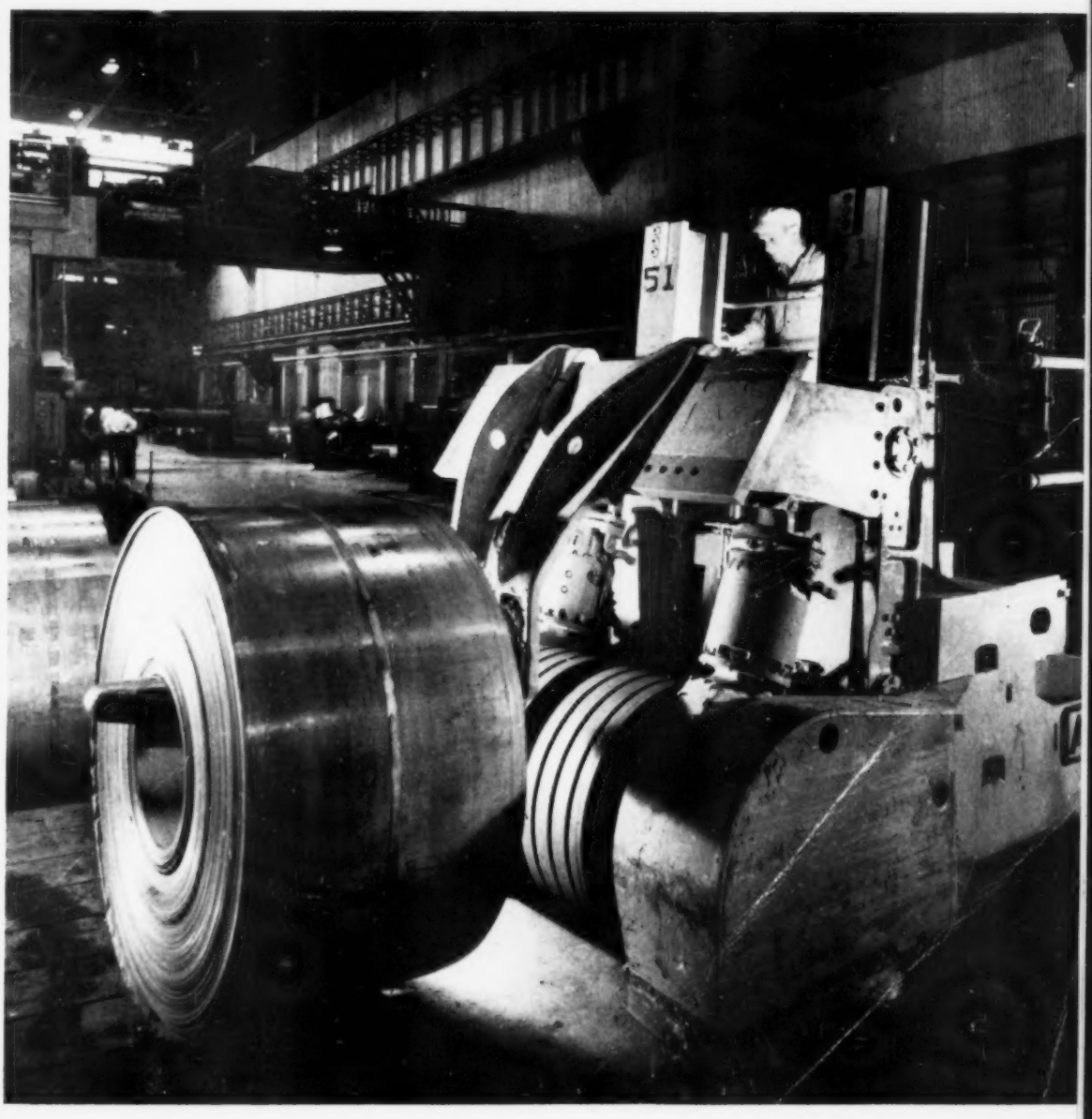
APPLIED HYDRAULICS

THE MAGAZINE OF FLUID POWER TRANSMISSION



RUARY, 1950

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IRCUITS

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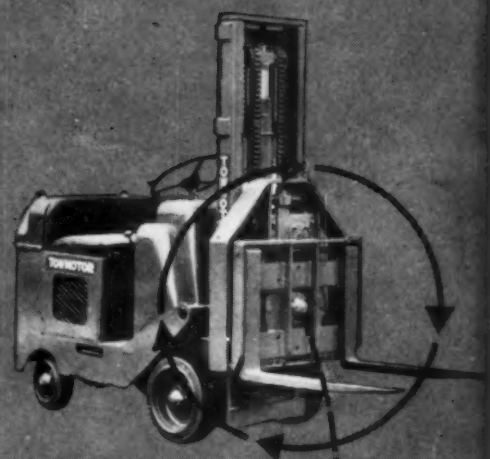
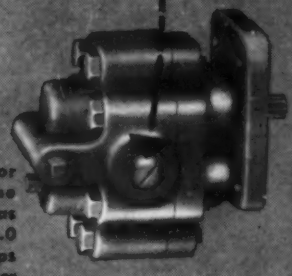
IN THIS ISSUE

Pesco

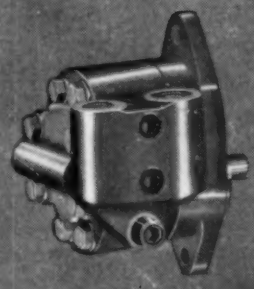
DUMPING MULTI-TON LOADS IN 5 SECONDS



The fork carriage of this Towmotor model revolves 360 degrees in either direction.



The hydraulic motor which revolves the Towmotor carriage has a displacement of 1.0 cu. in. and develops 14.5 in.-lbs. torque per 100 p.s.i.



This Pesco hydraulic pump which develops the power for the above motor has a displacement of .577 cu. in. Capacity: 3.5 g.p.m. at 1500 r.p.m. at 1000 p.s.i.

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APPLIED HYDRAULICS
The Magazine of Fluid Power Transmission

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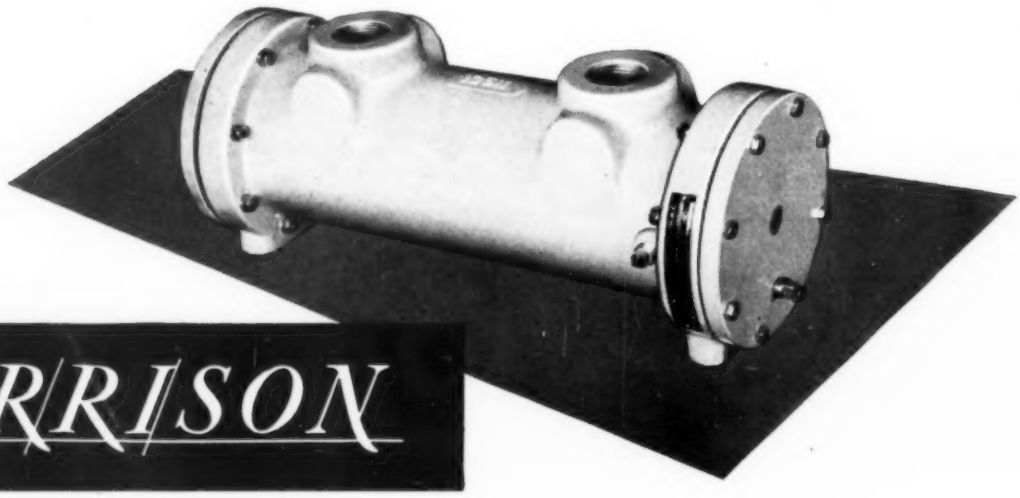

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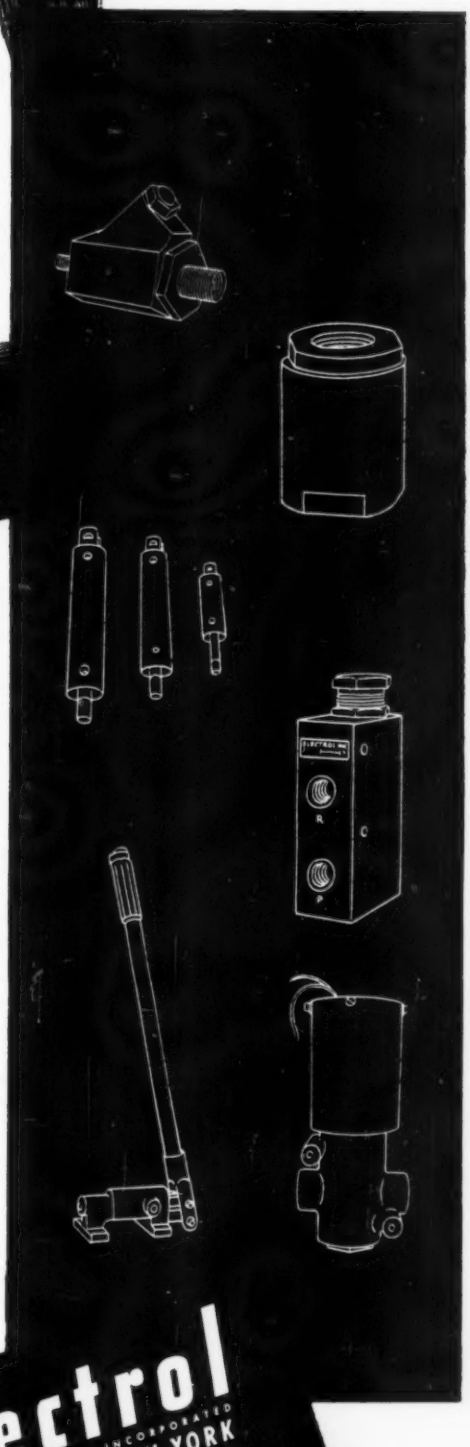

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LETTERS to the Editor

May we suggest that more attention be given to controls in your installation stories? The selection and application of controls is just as much a part of our selling job as the hydraulic and air units we handle.

D.L.K.

Thanks, we agree with you. In our general editorial plan for 1950 we will not only try to get more details in installation stories on controls but we have included an increasing number of proposed articles on types of controls and their applications to hydraulic and air circuits. A part of this program is a series of master-electrical circuits which a successful hydraulic and air salesman uses regularly.

We miss the very good air circuit articles by W. J. Schupner that you used to run regularly. Can we have more of these?

S.W.C.

Mr. Schupner's series will continue. We hope to have his next article, "Air Circuit for Clutch Control", in time to use it in the March issue.

The copy of APPLIED HYDRAULICS that circulates through our organization doesn't always reach me since I'm near the end of the line. I would like to suggest that you imprint lines for initials on a corner of your cover.

P.G.

While the suggestion is a good one, we believe that there is space in the left panel of the front cover for 10 or more sets of initials. We suggest that the individual whose initials are at the "end of the line" be responsible for checking on the progress of the copy as well as its final disposition.

Once or twice you ran a nomenclature list of technical words used in your articles which we found valuable to our young engineers and maintenance men. May we suggest that your editors do this more often?

L.K.

You certainly may, and we agree it is a good idea. We will try to include such nomenclature lists more frequently.

We have been getting some good operating and maintenance ideas out of APPLIED HYDRAULICS but we have seen very little on flexible couplings. How about running one or two good application stories on these?

L.P.B.

From your letterhead we deduce that by flexible couplings you mean couplings between drive and driven shafts. We have put this suggestion in our editorial work file.

I have a son who was graduated from Bucknell University as a mechanical engineer, and I would like to have him instructed in hydraulics. Is there any particular school of that type, or are there any companies at which he could get this training by taking a position with them?

F.L.E.

There are two men in the New York area who would be able to advise your son in regard to a hydraulic training course. Dudley Fuller, professor of mechanical engineering at Columbia University, or E. L. Midgett, professor of mechanical engineering at Polytechnic Institute, Brooklyn, would be glad to be of assistance. Professor Fuller is also chairman of the Education Committee of the American Society of Lubrication Engineers and is in touch with a number of schools and industrial organizations that are carrying on courses or training programs in hydraulics.

I have just noted the news item in your January issue regarding a course in industrial hydraulics at Fenn College in Cleveland. Could you put us in touch with the sponsoring organizations or the instructor? Our regular maintenance men have asked for some systemmatic instruction hydraulic circuits to help them take care of the steadily increasing number of hydraulic machines in our plant.

B.D.

The course in Industrial Hydraulics at Fenn College in Cleveland was sponsored by a committee of engineers under the leadership of E. M. Hoffman of the E. Hoffman Engineering Co., the committee working as a committee of the Cleveland Engineering Society. The instructor is Robert L. Hall, an experienced hydraulic engineer. Mr. Hall's outline of the course, which is given one evening each week for a two hour period, has been mailed to you.

In the Letters to the Editor column for December you mention the new cylindrical type of accumulators. Will you give us the names of the manufacturers who make these?

B.Y.

As far as we know the cylindrical accumulator is not yet available. The designs are still in the development stage. However, a number of companies including The Parker Appliance Co., Pacific Division, Bendix Aviation Corporation, the Sprague Engineering Co., Vickers, Inc., Cornelius Company and Simmonds Aerocessories, Inc., are either interested in or working on these units. At the last SAE A-6 Committee meeting in November a representative of the Bureau of Aeronautics, Navy Department, presented a proposed envelope for this type of accumulator, as had been requested at the previous meeting of the Committee in April, in which 5 sizes of accumulators—25, 50, 100, 200 and 400 cu in volume capacities—were shown. It is understood that interest centers in the 1500 and 3000 psi pressure classifications.

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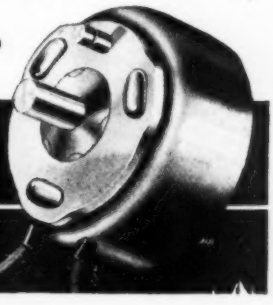

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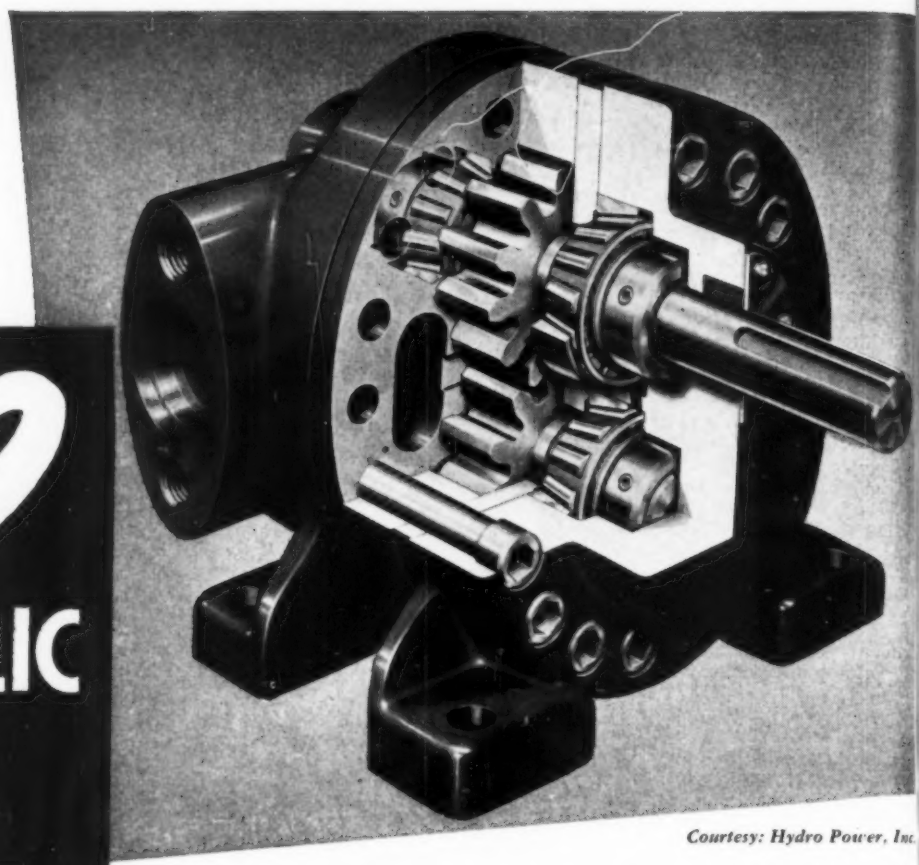

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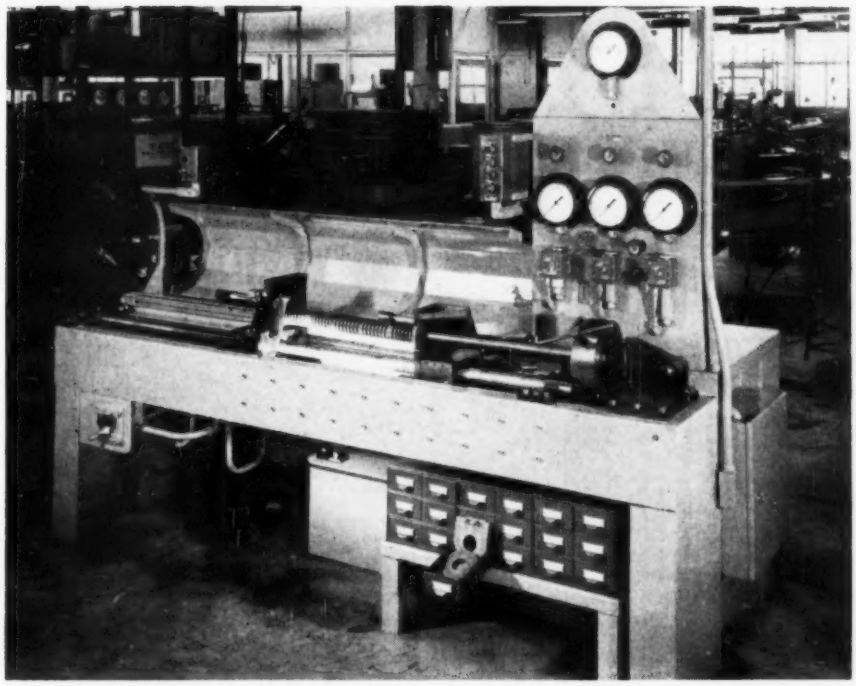


Fig. 1. Front of machine, loaded and ready to cycle. Open drawer (below) shows method of storage of arbor and split ring collars. Rings are provided in a number of sizes to fit mandrel and springs being compressed.

The design of a hydraulically actuated spring compressing machine that represented "a very great advance" for a specialty manufacturer. Increased production, flexibility of power and pressure and minimum maintenance were among principal advantages achieved.

Compressing Springs Hydraulically

By Albert L. Godshall

Designer
Hunter Spring Company
Lansdale, Pa.

IN THE MANUFACTURE OF PRECISION springs a compressing operation is used to impart specific characteristics which may be desirable. Since it has been determined that a spring that has once set will compress a greater distance without further set than a spring that has not been set, springs are either cold set or compressed to improve their quality. A new spring compressing machine, hydraulically actuated and designed for automatic operation, was designed and built by the Apparatus Division of Hunter Spring Company. The new machine has increased the speed of compressing over other methods previously used and has given cost savings as much as 20 percent on wire sizes 1/8 inch diameter minimum to 5/8 inch diameter maximum.

Editorial Note:
The Hunter Spring Company has pioneered many instruments for measuring physical and performance characteristics of springs. This activity resulted from their experience in the manufacture of precision coil springs, their principal product.
The hydraulic and electrical circuits were designed by the Battersby Company, who also supplied the equipment.

Previous methods used for compressing springs were hand setting or pressing, kick press, punch press and small hydraulic presses. The more usual method was to compress springs one at a time on a punch press.

The new machine, whose hydraulic and electrical control methods will be described, was a very great advance in spring compressing. We had the advantage that we knew exactly what we wanted to do with such a machine so that we could proceed with the design with not only the characteristics of the springs in mind, but with a fresh point of view in regard to the design considerations for the machine we needed.

Fig. 2. The operator is in the act of loading 2 in OD springs of ¼ in oil tempered wire on the mandrel. The tail stock hinge is open to receive the mandrel.

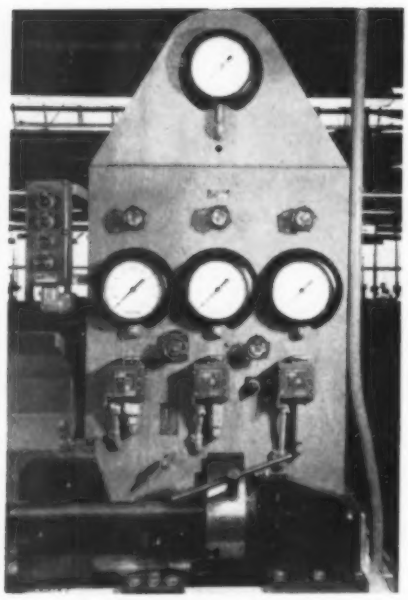


Fig. 3. Control panel, showing gauge (top) which indicates pump pressure being used, selector valves, working pressure gauges and pressure switches, adjustable relief valve (between PS 1 and 2), shut off valves, selector switch for pressure switch being used and operating pushbuttons.

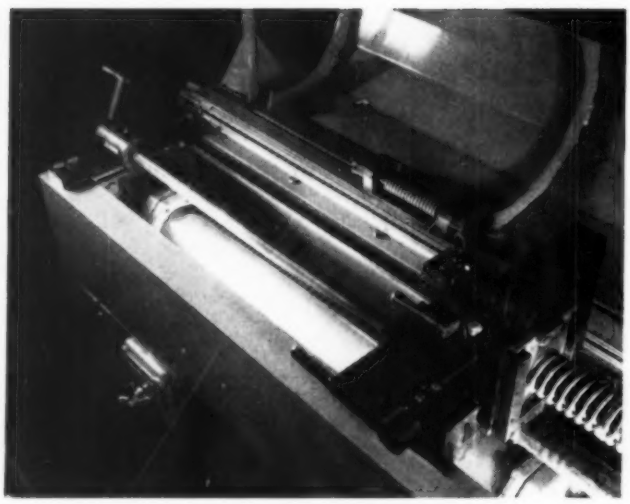


Fig. 4. Left end of machine, the tail stock position, showing tail stock cam lever in locked position and the hydraulic cylinder in the machine bed. The lead screw, operated by a crank handle, is used to position the tail stock.

Our requirements for a successful machine to compress springs were that: (1) a considerable selectivity of pressure ranges be available for the closing ram pressure; (2) the control of pressure ranges be easily and positively achieved; (3) the machine be easy to load and unload; (4) automatic operation be incorporated for efficient operation and maximum production; (5) the actuating and control circuits be as simple as possible to perform their functions; (6) key components be easily accessible for service and maintenance and (7) the machine be capable of long, accuracy life.

Other types of actuation were considered but since our basic requirements were met so well with a relatively simple electrically operated hydraulic circuit controlled by pressure switches, the machine was designed from the start with hydraulic pressure as the work power. The clean overall design of the machine, including the electric and hydraulic circuits, passed the last critical test in our own shop—the operators took pride in it and this has been a factor in keep the machine in its top operating condition and maximum efficiency of production.

The hydraulic circuit consists of a hydraulic pump unit, four-way double solenoid operated, spring centered valve, a 1500 psi double acting hydraulic cylinder of 3½ in bore x 36 in stroke, valves, limit switches, pressure switches, pressure gauges and control and operating accessories.

The hydraulic pump unit consists of a 10 hp 1200 rpm electric motor which drives, through a flexible coupling, a special gear pump with a rated delivery of 20 gpm at 750 psi, adjustable relief valve, pressure gauge and gauge shut off valve, all mounted on a 60 gallon reservoir equipped with baffle plate, combination filter, screen and breather cap and oil level indicator.

A dial type speed control, Figures 1 and 5, for manually setting the rate of cylinder travel is mounted at finger tip level at the left front of the machine.

The spring compressing machine takes arbor sizes from ¼ in to 3 in diameter. Figure 2 shows an operator loading 2 in OD springs on the mandrel. The maximum length the machine will accept is 66 in; the amount of compression and the length of the hydraulic cylinder stroke is 36 in. The total force exerted is 6000 pounds for a ram speed of approximately one foot per second.

Set Up Procedure

The set up procedure will be combined at this point to clarify the sequence of operations. With the

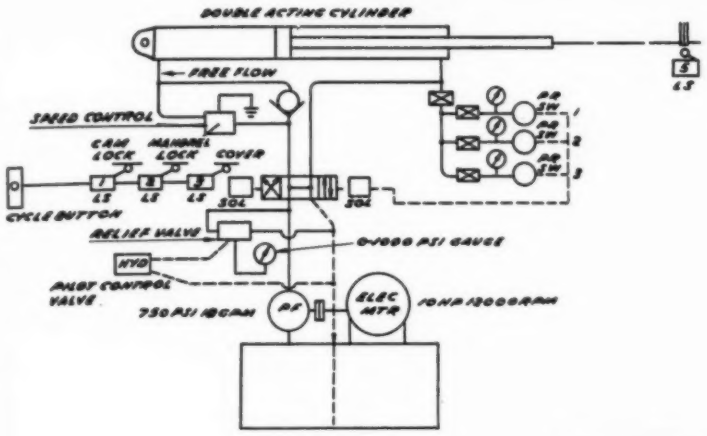
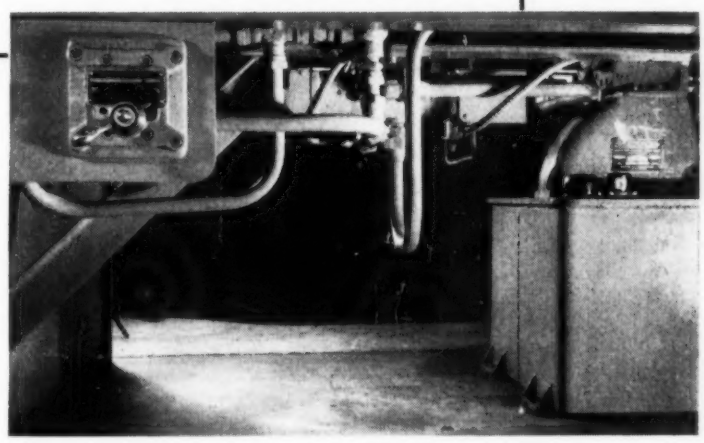


Fig. 5. Schematic of the hydraulic circuit of the spring compressing machine.

Fig. 6. Front view of the base of machine showing dial type speed control (left), and hydraulic pump unit assembly (right).



machine stopped and the cover open, the operator: (1) inserts the correct size arbor into the chuck; (2) slides the correct size ring over the arbor between the ram and tail stock; (3) with the tail stock hinge in closed position, inserts a split ring collar into position; (4) adjusts the tail stock position so as to be able to use the maximum length of arbor (Figure 1); (5) loads springs on the arbor (Figure 2); (6) swings arbor into compressing position; and (7) closes tail stock hinge on mandrel by operating the hinge lever 180 degrees.

The machine is now ready to start. The operator closes all valves on the control panel except the valve directly above the three position selector switch (Figure 3). This valve is left full open. The pump unit is started by pushing a starting button on the push button station at the left of the control panel. An auxiliary operating station is mounted on the left end of the machine for the convenience of the operator (Figure 1).

The jog button on the push button station is used to compress the spring in small increments. The ram will move only as long as the button is depressed. After the ram has been moved and the jog button is no

(Continued on page 28)

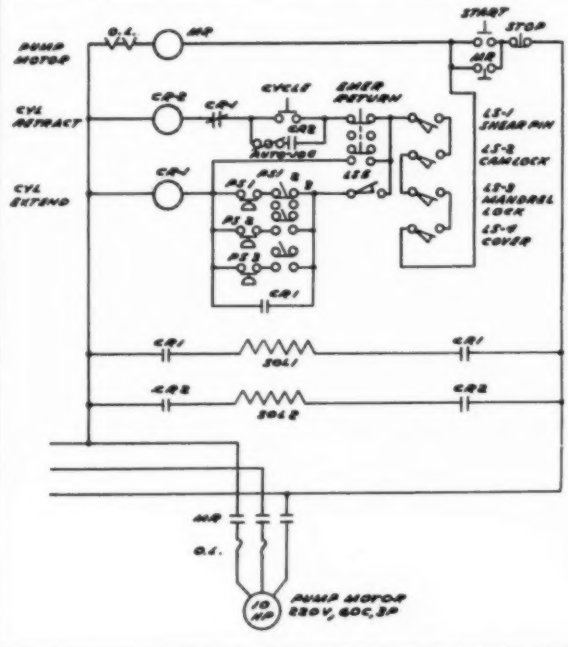
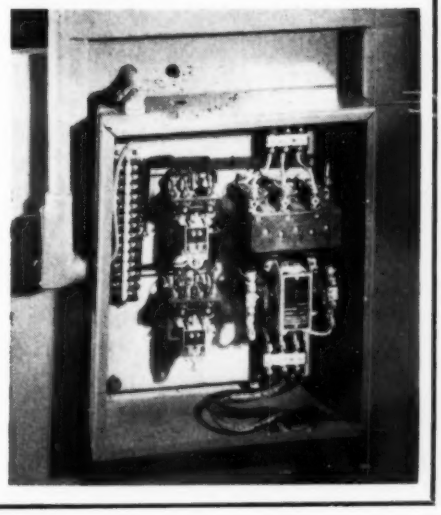


Fig. 7. Diagram of the electrical control circuit.

Fig. 8. Electrical control panel showing motor starter (right), two contactors for valve solenoids and terminal block (left).



THEORY AND PRACTICE IT

By R. O. ISENBARGER

PART I

THIS PAPER WILL ATTEMPT TO cover the field of hydraulic seals in general, i.e., without reference to the products of any particular manufacturer. The subject covers such a large range that it is not possible to discuss all points to the most desirable extent. Many less important points are omitted. The first portion of this paper is concerned with important points of the general theory from a practical standpoint, leaving a discussion of individual types of seals, their specific theory, uses and limitations for later treatment.

Theory And Practice

The phrase "theory and practice" was used to emphasize the fact that in this field theory is especially dependent on the experience gained by actual application and vice versa. Reasons are that the properties of the non-metallic materials used in seal construction are not as predictable as those of metals and the fact that a great number of external factors affect seal function.

The theory of sealing is still in its infancy. Very little published material is available. The rapid development of machine design in late years has created a necessity for increased research in seal design. The severity of the conditions under which seals function is increasing at a rapid rate.

Definition Of A Hydraulic Seal

A hydraulic seal might be defined as a device to prevent the escape of fluid between two parts of a mechanism. This definition is both too inclusive and, in some respects, incomplete. For clarity, it might be best merely to point out deviations and supplement later with descriptions of the various types of seals used. While this definition would include the gasket, this subject was very adequately covered by H. H. Dunkle at the last meeting of this group* and will not be further discussed. Certain devices such as close clearances to reduce leakage (with drain backs to the reservoir or sump), spiral threads on revolving shafts to pump the leakage back into the mechanism, slingers, etc., cannot be called seals, although they are used under certain conditions to inhibit leakage. The grooving of shafts or housings with annular recesses to inhibit leakage by setting up Taylor vortex motions as described in the paper given by W. W. Hagerty at the 1947 Conference** is not included. On the other hand, it seems desirable to mention devices which act to protect the mechanism from dirt and foreign material from the outside, and in many cases, to protect other seals. These devices may not always take the form of seals, but may be protective movable coverings called dust boots or, sometimes, diaphragms. The diaphragm is often used to perform the dual purpose of a confining and a motivating member.

* "Gasket Design and Selection", by H. H. Dunkle, Vol. 2, "Proceedings of the National Conference on Industrial Hydraulics".

** "A New Factor in the Design of Hydraulic Seals", by W. W. Hagerty, Vol. 1, "Proceedings of the National Conference on Industrial Hydraulics". An abridgement, "Designing a Hydraulic Seal", appeared in APPLIED HYDRAULICS, February 1948.

OPERATING CONDITIONS WHICH INFLUENCE SEAL DESIGN

(a) *Major*
- Frictional speed
- Temperature
- Pressure differential across seal
- Materials sealed in and out

(b) *Secondary*
- Finish and material of contacting surfaces
- Eccentricity
- Amount of lubrication
- Viscosity of the medium
- Wobble, whip, end play and vibrations involved in motions of the surfaces

(c) *Minor conditions*

This paper was delivered at the National Conference on Industrial Hydraulics, Chicago, October 26, 1949. This and other paper of the Conference will be published in the Proceedings which will be published by Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

Effects Of Operating Conditions On Seals

It is obvious that a given design will function only within certain limitations, and that these limitations are dependent upon the operating conditions. In a given application the operating conditions are set, but are seldom all known. Usually the main conditions which the seal must withstand, such as temperature, pressure, speed, etc., are known. In addition, numerous minor conditions usually exist, which, since they affect the seal function, are important. Some of these are not only unknown, but are indeterminate. When the main conditions approach the limitations of the seal, these minor conditions become particularly important in determining the success or failure of the seal. The design of the best seal is dependent upon the complete set of conditions, therefore, it is of prime importance that the seal supplier be given all the known conditions. Figure 1 shows a change of recommendation due to the importance of a normally minor condition. Even conditions which at first seem trivial are often decisive in determining the type of seal which should be used. Wherever possible, the seal supplier should be furnished a drawing or sketch of the

THE DESIGN OF HYDRAULIC SEALS

installation showing the part to be sealed. This should have sufficient detail to show how the mechanism operates, as this will often furnish clews which might otherwise be overlooked.

It is misleading to state that a given design will function within a certain range of values of a given condition, since the ability to function at any time is dependent upon the combined effect of all the conditions existing at that time. It is important to know not only as many of the conditions as possible, but their coincident values as well. While it might be true that none of the conditions are serious in themselves, their combined effect at some part of the operating cycle might be critical. A simple and obvious example of this would be the relation of pressure and speed on an ordinary shaft seal. The speed the seal can stand decreases as the pressure increases.

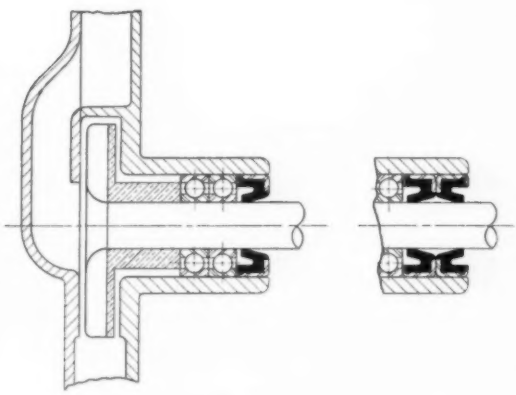


Fig. 1. The seal on the low pressure water pump (left) was designed only to seal the pumped fluid. However, at times the pump created a vacuum at the seal drawing air through it. A second seal, facing outwards (detail at right) was installed to prevent this and the troublesome entry of dirt.

If only these two conditions or variables were involved, the problem would be simplified. Actually, the allowable speed at a given time is dependent upon not only pressure but shaft finish, ambient temperature, eccentricity, amount of lubrication, viscosity of the medium and the values of the many other variables existing at the time. Before discussing the actual operating conditions, it is necessary to discuss the general conditions for sealing and some definitions involved therein.

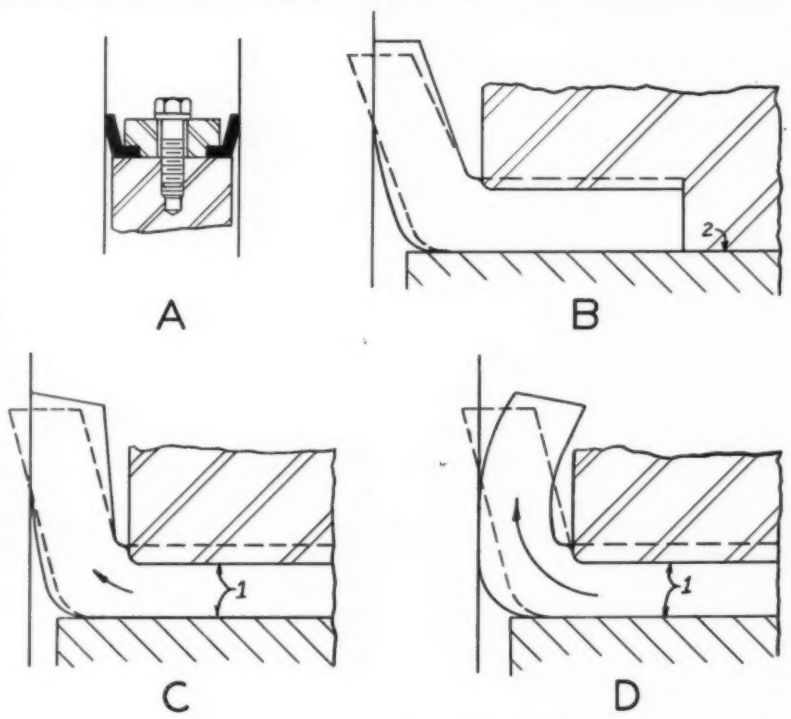


Fig. 2. The relation of design to materials is illustrated by cup installations in a hydraulic cylinder ,"A", and details "B", "C", and "D". Dotted lines represent the initial shape, solid lines the final shape. "C" shows a leather cup compressed at the center. Leather fibers at 1 have taken up most of the compression. "D" shows a synthetic rubber cup of the same original shape as "C" and subjected to the same amount of compression. Due to the non-compressive and flow characteristics of the rubber, serious flow and distortion has taken place. These objectionable characteristics are considered in the design and installation of the cup at "B"; the amount of compression is limited by metallic contact at 2 and the cup is shaped to prevent the effect shown at "D".

General Conditions For Sealing

In general, a seal is required to prevent the passage of some medium between two parts of a mechanism. Usually, the opening between these parts in which a seal is placed is annular or ring-shaped. The required seal is dynamic or static, depending on whether these parts do or do not have relative motion with respect to each other. The seal may or may not be rigidly attached and sealed to one of these parts. In some cases the seal depends merely on sufficient contact for sealing. To insure sufficient contact, the seal must be constructed so as to apply enough pressure at right angles or normal to the surface. This normal pressure will be called the contact pressure to distinguish it from the pressure of the medium, i.e., the hydraulic pressure. The surface of the seal over which the contact pressure acts is called the contact surface. The part of the mechanism against which the contact surface acts is called the sealed member. If there is movement between the contact surfaces and the sealed part, and this is the case for a dynamic seal, it is usually desirable to keep the resulting friction low. This can be done by reducing the contact pressure but not, of course, to the point where leakage will occur.

The optimum contact pressure, it would seem, would be slightly higher than that at which leakage would occur under any conditions which might exist at any time. However, this is not always true with a given seal. For example, consider the common type of seal in which the contact surface is a synthetic rubber or leather lip held in contact with a rotating shaft by means of a garter spring surrounding the lip. If this seal leaks under some set of conditions, it would at first appear that the thing to do, assuming that additional friction is not objectionable, would be to replace the spring with one that would give more compact pressure. The spring may not be proper for the conditions to which the seal is subjected. On the other hand, by actual test of this type of seal under severe conditions, it is found that leakage decreases with increased spring pressure only to a certain range of spring pressures, and if the spring pressure is increased above this range, the leakage increases. If a seal leaks when the spring pressure is in this optimum range, the fault is not with the spring, but with some other detail of the seal design. For the operational conditions involved, the lip may be either too stiff or too flexible, its shape may not be right, or one or more of many design details may be incorrect. One probable explanation is that at a certain contact pressure, the contact surfaces no longer slide over each other evenly, but move with a series of minute jumps so that the surfaces separate at short intervals. Briefly and obviously, the correct seal is one in which the seal itself is not penetrated by the sealed medium and the contact is maintained under all of the operational conditions involved.

Operating Conditions

Because of the complicated interdependence of conditions, it is difficult to discuss any one condition by itself. Practically all the conditions can be discussed in relation to their interdependence with the four most important conditions—shaft speed, temperature, pressure and materials to be sealed in and out. In general, the allowable speed is dependent not only upon temperature and pressure, but also upon finish and nature of the sealed member, the amount of eccentricity, wobble, whip, end play and vibration involved in the motion of the surfaces, the nature of the sealed medium and the amount which reaches the seal and other conditions.

Excessive pressure often builds up due to heating in unvented gear

(Continued on page 20)

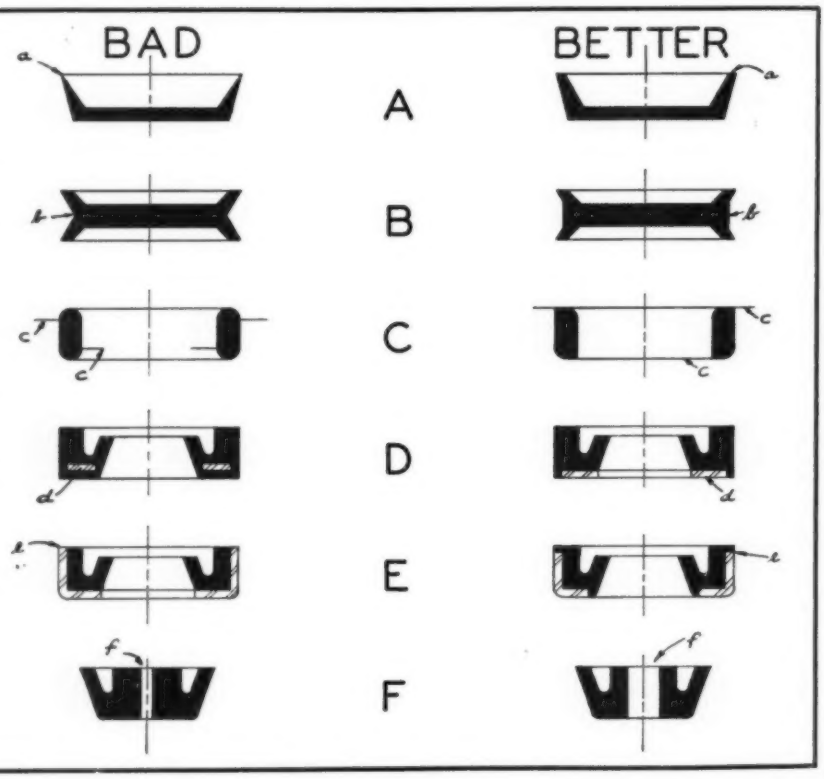


Fig. 3. Designs for economical molding. "A"—the sharp edge (left) is very difficult to mold and trim accurately. The flat a (right) is easier to mold and trim. "B"—the deep undercut (left) complicates part removal from the mold. Reducing the undercut (right) simplifies the molding problem. "C"—the parting lines of this static seal (outside and inside at left) give flashes difficult to trim; the better design (right) has bottom inside and top outside corners easily flash trimmed. "D"—unanchored metal inserts (left) cannot be positively located; insert (right) can be guided both at its center and bottom. "E"—Rubber flush with steel shells (left) is difficult to clean and trim; this is overcome by extending the rubber slightly above the shell (right). "F"—center hole of part (left) is formed by a slender pin easily bent or broken by molding stresses; by increasing the hole diameter (right) a larger, sturdier pin may be used.

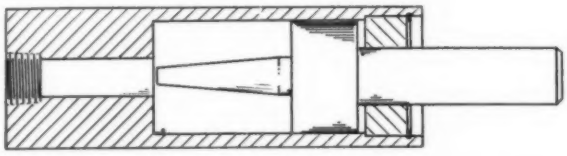
HERE'S HOW

- PREVENTIVE MAINTENANCE
- SERVICE PROCEDURES
- MODERNIZATION
- SHORT CUTS

Hydraulic Dashpot

OCCASIONALLY we have the problem of smoothly stopping a fast moving piece of equipment in a minimum of travel. It is our practice to use an oil dashpot, built as indicated in the sketch, Figure 1. We arrive at the full diameter of the dashpot by calculating roughly the force at impact and allowing sufficient dashpot area to keep the oil pressure within reasonable limits. The length of the dashpot is usually a compromise between judgment and allowable time for deceleration.

The real problem arises in connection with the development of the plug or needle which restricts the outlet from the dashpot chamber. In fact, we have found it advisable in some cases to start with a needle which initially imposes too much restriction, and by hand filing relieve and test until we obtain the desired results. We are able to cut and try until the proper smooth deceleration results. However, we do not have a measurable contour when finished which will serve as a guide for future use.



As an example, we installed a dashpot on a moving carriage weighing 1150 pounds and which was travelling at approximately 32 inches per second at the point of dashpot contact. We used a 2 in diameter dashpot with a needle 3 in long and were able to get a very smooth stop within the three inches allowed for deceleration. We started with a needle which immediately imposed a severe restriction to flow, resulting in definite shock in the equipment. By filing flats on the needle and advancing these back from the tip as tests directed, we obtained a smooth, shockless stop.

The difficulty is that our cut-and-try leaves us with a needle that is beyond reproduction.

Now that we have tried to answer a question; we would like to ask one of the readers of APPLIED HYDRAULICS. More specifically we have four questions on the possibility of turning the needle to a reproducible contour in advance. We hope that one of your readers may have a simple answer to this problem. The questions are:

(1) What oil velocity through the outlet may be considered as an initial resistance velocity when the needle starts to restrict flow?

(2) Assuming that this initial velocity will be a variable according to the pressure in the dashpot, can it be established for pressures of perhaps 500 psi, 1000 psi, 1500 psi, 2000 psi?

(3) Assuming that variables in temperature of 50 F to 100 F can be anticipated, what type and grade of oil is most suitable for such service?

(4) For general application, such as the problem outlined above, can the needle be a straight line taper from initial entrance to the fully closed position?

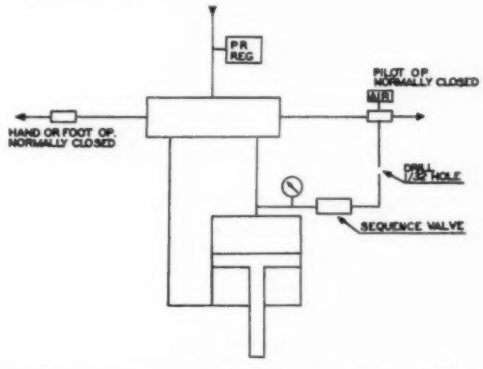
E. F. HEISER
S. G. MORRIS
7829 Euclid Ave.
Cleveland 3, Ohio

Automatic Piston Retraction

IN SOME assembly methods such as crimping and staking, it is necessary to use large bore air cylinders of 6 in diameter and more. During the closing part of the stroke, very little resistance is encountered so that the piston descends without using full air line pressure. The actual pressure obtained at the end of the stroke may be only a fraction of the theoretical pressure unless the valve is held open long enough to permit the pressure to build up inside the cylinder. Experience has shown that this dwell should not be entrusted to the operator's judgment, as it may result in insufficient pressure or excessive dwell.

Differnt automatic methods are in use in obtaining dwell; however, in the writer's experience, the system described and shown in Figure 1 permits the most accurate setting of desired pressure with the minimum amount of unnecessary dwell time.

A pilot operated four-way master valve is used that requires two auxiliary bleeder valves. The momentary operation of either bleeder valve causes a shift of the valve spool, resulting in movement of the double acting cylinder piston. The bleeder valve that causes the piston to advance is under control of the operator and may be hand or foot operated. After the piston has advanced and reached the end of its stroke, pressure builds up, which, after it reaches a predetermined value, opens the sequence valve. Since the sequence valve has been adjusted for the desired pressure, air pressure is admitted to the pilot side of the pilot operated bleeder valve, which consequently opens. This causes the master valve spool to shift and thus return the piston to its starting position.

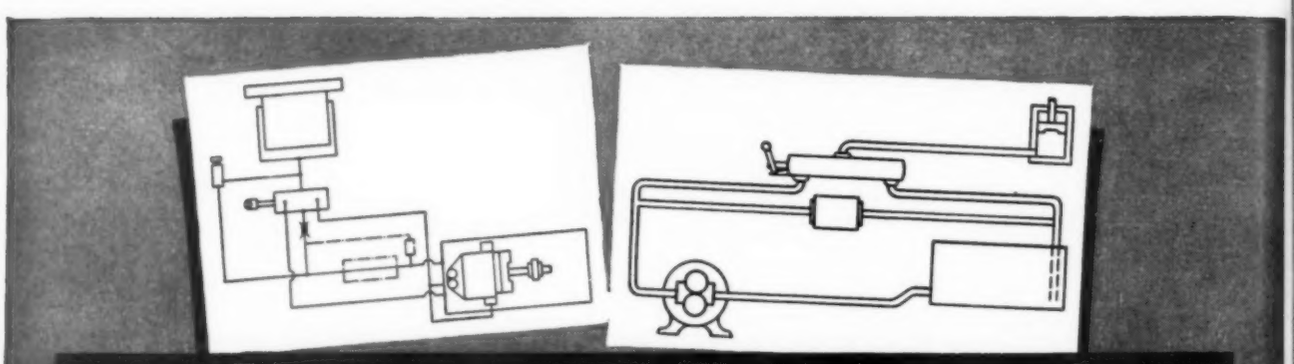


Since the sequence valve closes as soon as the piston retracts, air under pressure would be trapped between the sequence valve and the pilot operated bleeder valve, so that it is advisable to drill a small hole in the line, as shown in Figure 1. This does not prevent sufficient building up of pressure to operate the pilot valve as long as the open sequence valve permits air flow; on its closing however, the hole bleeds off the trapped pressure.

This system has proved itself reliable and accurate and can easily be assembled from commercially available units at a cost only slightly higher than that of a non-automatic system.

PAUL H. WINTER
109 Archer Road,
Syracuse, N. Y.

Readers are invited to contribute their short cost and labor saving shop or plant ideas. Each contribution will be acknowledged and considered for publication. We will pay $5.00 for each item published. —Here's How Editor



A Beginner's Course in Basic Hydraulics

Chapter V

SIMPLE VALVES

What Valves Are And How They Are Used

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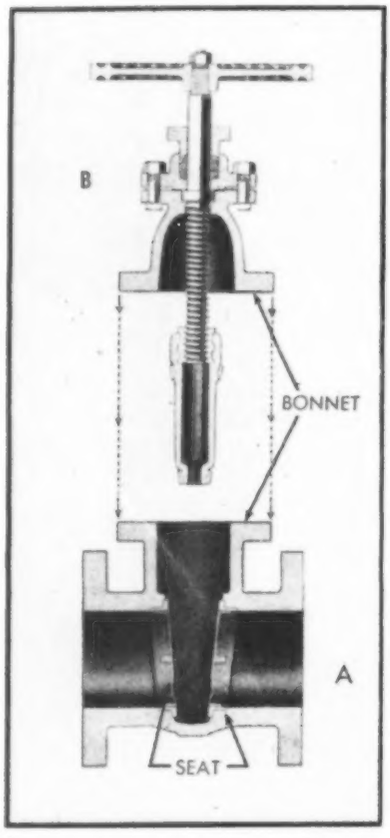

Fig. 66. Schematic view of the elements of a gate valve.

Definition and use. From time to time we have had occasion to refer to valves for controlling the fluid in a hydraulic system. Let us now give our attention to this device, which for the purpose of definition, is any device that is used for controlling the direction of flow, the volume or pressure of a liquid which is used for mechanical operations. A handbook of a leading industrial technical institute defines a valve even more simply as "mechanical devices to start, stop or otherwise regulate the flow of a liquid".

It is all but impossible to develop a practical hydraulic system without using valves; it is equally difficult to operate a hydraulic system without knowing how to control its valves and insure their efficient operation. Valves may be located either at exits from the system or within it.

In spite of the number of specialized functions of many modern hydraulic valves, all valves by their similarity of construction fall into three general groups: the needle, gate and globe type, the ball check type and the piston type. A little later we will separate valves into three functional groups to correspond to our definition. However, in this chapter, we will discuss the valve types, beginning with the simplest from the standpoint of construction. Specifically these will be the gate valve, the globe valve and the needle valve.

Gate valve. The gate valve, Figure 66, is used to start, stop and sometimes to manually limit the flow of a liquid. Flow is controlled by a wedge or gate which can be moved up and down across the line of flow by a handwheel to open or close the passage. The principal elements of this type of valve are indicated schematically in cross section in Figure 66.

A shows the pipe connection and the outside structure of the valve, while B shows the wedge or gate inside the valve and the stem to which the gate and handwheel are attached. When the valve is open, the gate stands up inside the bonnet.

(Continued on page 34)

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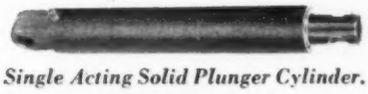
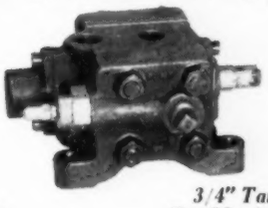


Single Acting Solid Plunger Cylinder.



3/4" Tandem Type Double Acting Valve.

Flange Mounting Single Type Gear Pump.

WRITE FOR DETAILED DESCRIPTIVE LITERATURE

The COMMERCIAL SHEARING & STAMPING COMPANY
YOUNGSTOWN 1, OHIO.

HYDRAULIC SEALS

(Continued from page 16)

cases or in gear cases where vents are not large enough or become clogged with dirt or paint, resulting in the demand for a pressure seal where otherwise a simpler seal could be used. In many cases excessive pressure is built up between a bearing and a seal due to a pumping action of the bearing. This is often relieved by boring a hole from the space between the bearing and the seal back to the main reservoir.

rubbers, it is important to select compounds which are not adversely affected. Care should be exercised to exclude foreign materials which may cause deterioration of the seal parts.

Types of motion are reciprocation, rotation, oscillation, which is a continuous reversing type of rotation, the wobble motion, such as given a lever moving back and forth on a pivot and combinations of these motions. Other conditions which are often troublesome are corrosion caused by chemical action, electrolysis and other causes of seal or sealed member deterioration.

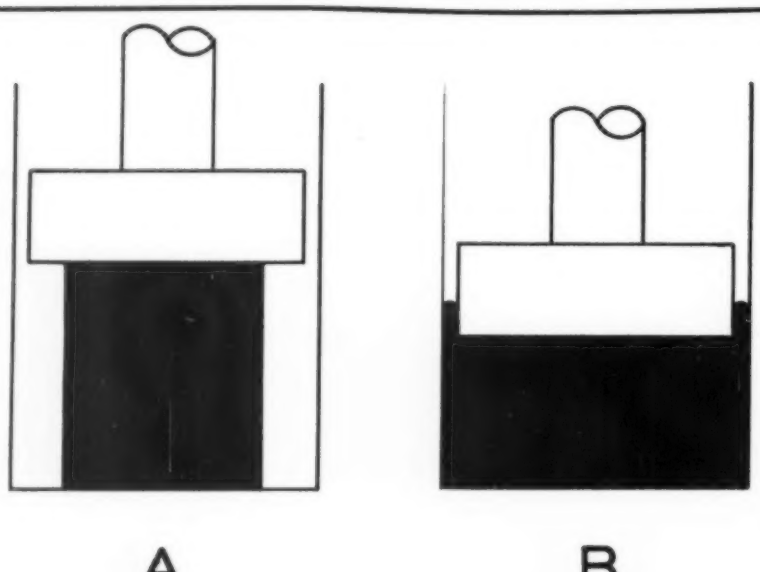


Fig. 4. The incompressibility and flow characteristics of rubber is illustrated. The volume of rubber under pistons "A" and "B" is identical. When pressure is exerted, rubber in cylinder "A" changes its shape to fill the cavity; in cylinder "B", with a close clearance between piston and cylinder, the rubber cannot escape and the piston could not be forced down further under pressures normally encountered in hydraulic work. If a clearance exists, as shown at "B", rubber will extrude around the piston.

The amount of heat at the sealing point is determined by the seal friction, friction of the bearing, friction due to oil agitation, gears and other parts of the machinery, as well as nearby clutches and other heat sources. Its amount depends upon these factors as well as the radiating and conducting capacity of the unit.

A very important condition is the effect of the medium to be sealed upon the materials of which the seal is composed, e.g., the high pressure and hypoid lubricants, also certain newly developed non-flammable hydraulic fluids. In the use of such fluids, in connection with synthetic

Sealing Material Properties

In seal design it is important that the properties of the material used be taken into consideration. Properties of the metals are well known, but those of the non-metallic materials, such as leather and synthetic rubber, are often overlooked. Since parts made from these materials cannot be held to as close tolerances as can metallic parts, it is important to make allowance for tolerances.

Leather is capable of being formed by dies and molds from flat pieces into many shapes as long as the shaping process does not involve too great a change from the original thickness of the flat sheet. The reason is that leather is a fibrous material in which the fibers are interlaced with extreme intricacy in such a manner as to form a material of great strength and considerable flexibility. However, it lacks the flow properties of synthetics and while it may be compressed in thickness, the other dimensions do no change proportionately. In other words, the volume of the material can actually be changed by compression.

In mechanical leather tanning, certain materials are added to give the required properties such as heat resistance, greater tensile strength, density and impermeability. The resulting leather retains some porosity which in many sealing applications is advantageous since it allows more or less controlled seepage to lubricate the seal. The porosity may be varied from the natural porosity down to practically zero porosity by the use of various impregnants such as waxes, plastics and synthetic rubber.

A characteristic of leather is its hydroscopic property. Its water content varies with the humidity of the surrounding air, causing dimensions of a leather part to vary slightly as the humidity changes. This property, while sometimes bothersome, is not serious. The water absorbing capacity of the leather is reduced somewhat by impregnating. Leather is ordinarily not recommended for temperatures exceeding 225 F.

For brevity hereafter, synthetic rubber will be referred to merely as rubber, it being understood that for most hydraulic applications using rubber, a synthetic product is required. Rubbers and plastics can be molded in a great variety of shapes —the moldability being limited only by the production problems in molding itself. It is important, however, to check any design to see whether it is moldable. Figure 3 gives examples of both poor and better molding designs. The part must have a form so that the mold can be properly loaded, that all the air will be driven out so that the part will have a maximum density and so that it can be removed from the mold without damage. It should be remembered that when molding the raw material, it is forced into the

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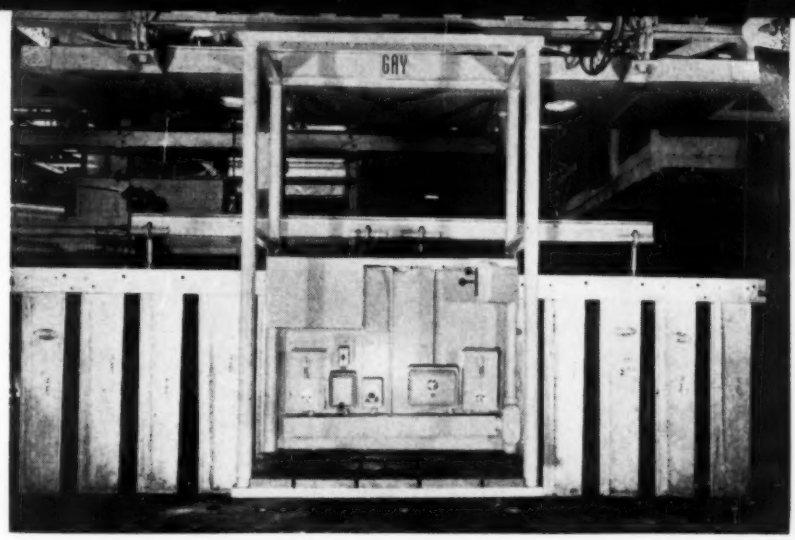


Fig. 1. A front view of the ice harvesting crane, which was redesigned to include hydraulic operation for smoother and more efficient operation.

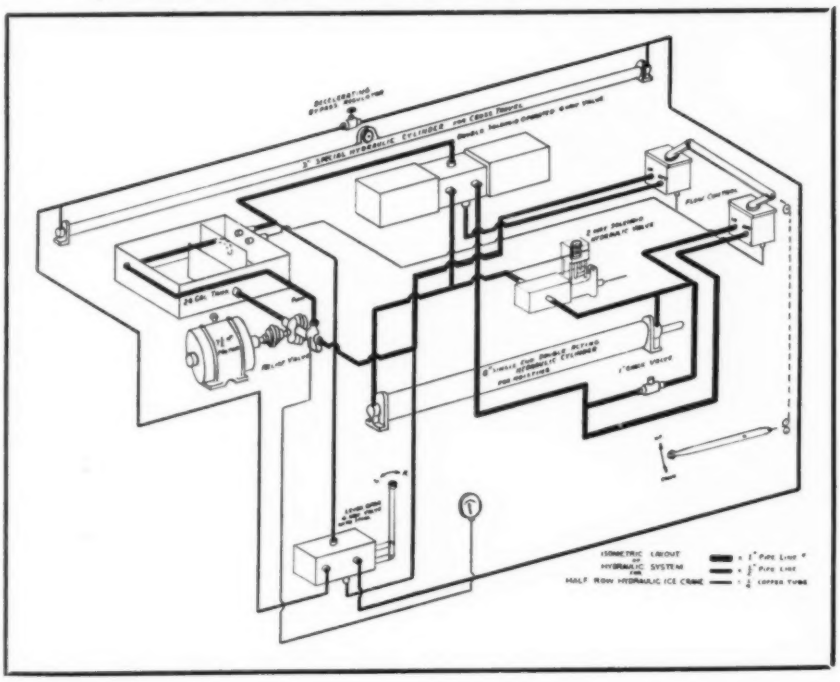
Harvesting Ice By Fluid Power

By HYMAN LEDEEN

THE GAY ENGINEERING COMPANY of Los Angeles builds ice cranes —a major production handling machine for ice making plants. The machine, formerly powered by a rather intricate electrical arrangement, had developed many operating difficulties which were eliminated by a redesign which incorporated a hydraulic system to operate and control two of the three basic motions.

Figure 1 shows a front view of the ice harvesting machine. There are three basic motions: (1) hoisting and lowering ice from a freezing tank; (2) left and right cross travel trolley motion; and (3) forward and reverse bridge travel.

Fig. 2. Isometric layout of the hydraulic system in the ice crane.



These three motions are usually accomplished by three individual slip-ring or hoist type motors controlled by two or three step electrical switch gear, operating through reduction gear train to one or more sets of trolley wheels. This method produces little or no difficulty for the third motion—the forward and reverse bridge travel, since the route is long, the speed high and the rate fairly uniform.

However, for the other two motions, this type of control causes many operating difficulties, especially with semi-skilled and inadequately trained operators. Even the most skilled operators cannot entirely avoid the shock impact loads each time that the hoist motion begins, each time the hoisting speed is changed and each time the hoist is stopped—an average of 13 to 20 times per trip. Nor can the most experienced operator avoid sudden starts, changes of speed and inaccurate positioning of the cross travel when this type of control is used.

The problem was to design and build a crane in which these difficulties were overcome or eliminated and to produce a crane which provided smooth starting and stopping, infi-

(Continued on page 40)

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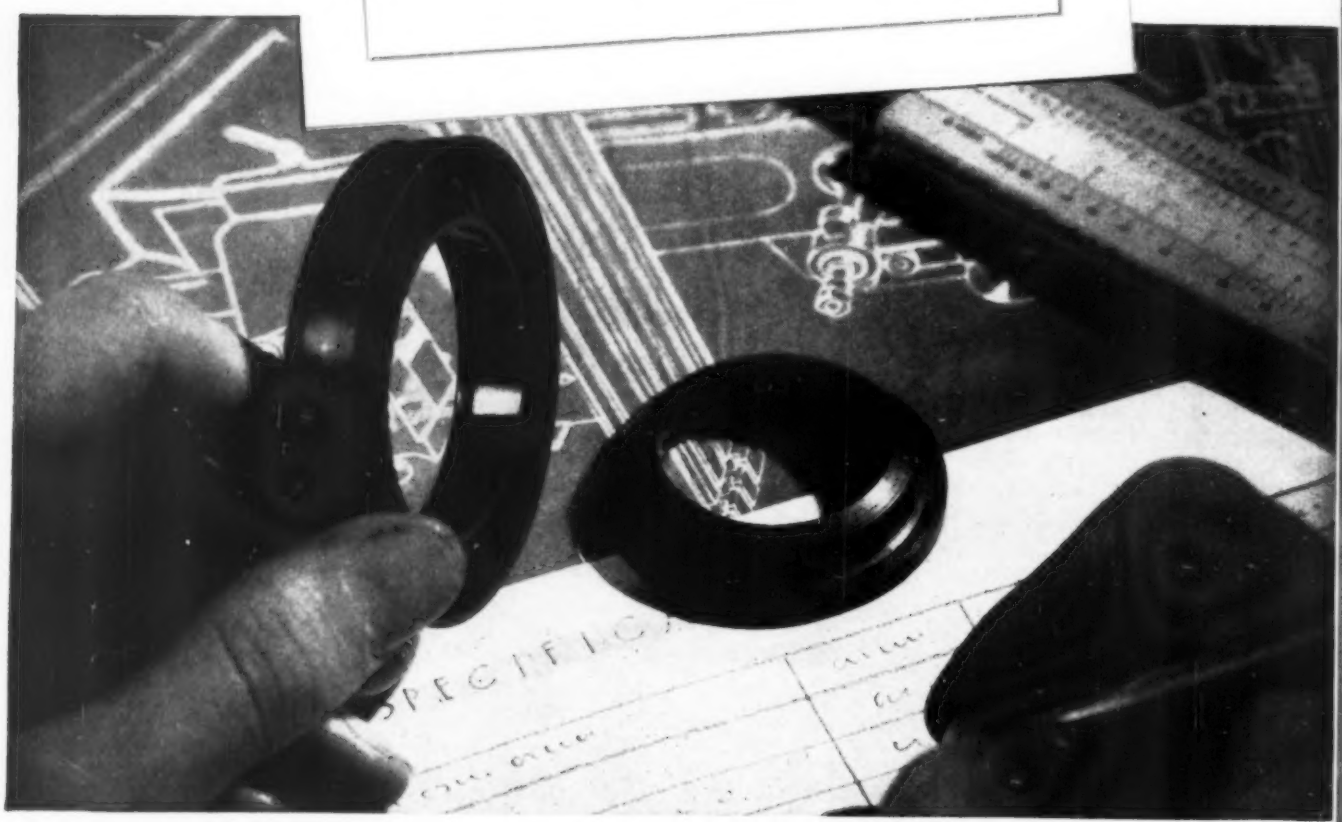

Yes, sir, if hydraulic design is your responsibility, and you desire advice on a packing installation, this is your invitation. Houghton hydraulic engineers have been doing that sort of first-aid for many years, which is one big reason why our packings are so well and favorably known. For proper recommendation of the right style of leather or synthetic rubber packings, contact E. F. Houghton & Co., Philadelphia 33, and all principal cities.

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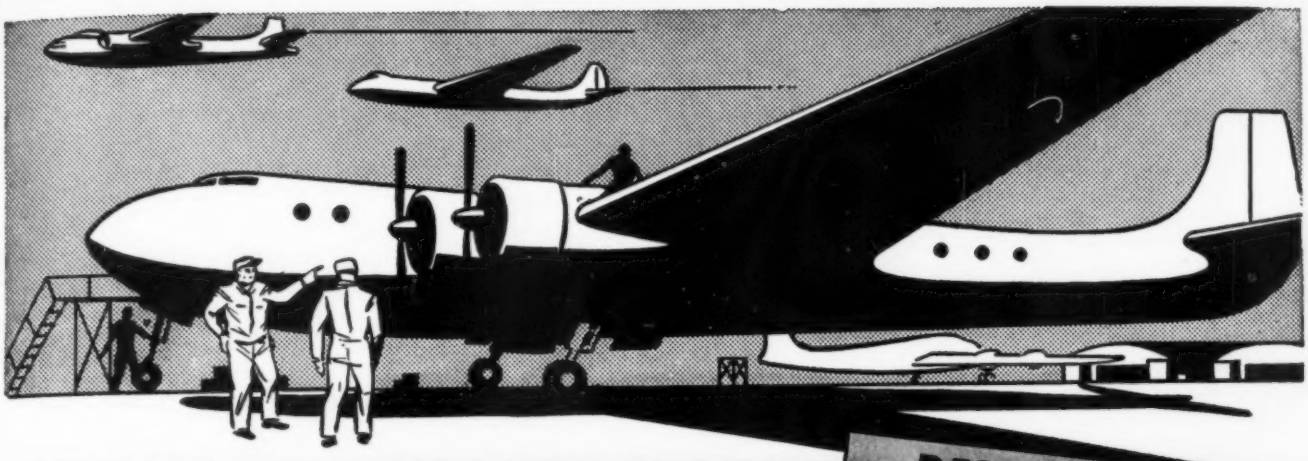

AVIATION HYDRAULICS

DESIGN
OPERATION
MAINTENANCE

FRED O. HOSTERMAN
Advisory Editor

Reduction of Hydraulic Noise and Vibration

PART II

By G. W. LOUTHAN
Mechanical Research Group Engineer
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Burbank, California

THE METHOD DESCRIBED IN PART I may not be feasible in all cases or may not provide the desired degree of noise reduction over the full range of output flow and pressure conditions encountered. Consequently, the remainder of this article will be devoted to a study of various devices which might be employed to absorb this noise and prevent it from being transmitted throughout the system. Application of the acoustic theory to the isolation problem led to the trial of a wide variety of devices, some of the main types of which will be reviewed briefly with some detailed attention to those which appeared to show the most promise.

In Part I of this article, attention was given to the basic form of hydraulic system noise and to the the principal source of such noise, the pump. An attempt was made to show at least one means of reducing this noise at its source, since this approach is the simplest and most effective. Further, elimination or substantial reduction of noise and vibration within the pump is the only method which offers protection for the pump itself and the possibility of extending its useful life.

Reflection Attenuators

This device rejects sound energy externally by successive reflections. For liquid compressional waves impinging on a solid boundary, a great many reflections are necessary to obtain much attenuation. This requirement tends to be inconsistent with those for weight, space and freedom of flow, but most of the basic objections were met by a somewhat novel design which consisted of a 5 in accumulator with the diaphragm removed, Figure 4. A 3½ in sphere turned from acrylic plastic was concentrically mounted inside. Pump flow traversed the annulus and left by the other port. The inlet tube retained a sensibly plane wavefront until initial impact on the plastic surface, after which the wave diverged symmetrically and crept forward through the annulus by repeated reflection. While tests on this device were restricted, a fair degree of attenuation was obtained at frequencies up to 160 cycles per second (cps), but a considerable increase in wave transmission occurred as the frequency increased.

Stewart Filters

These consist of a series of separate chambers disposed along a line and each is connected thereto by one or more holes. The simplest con-

This article is condensed from a Lockheed report of the research work done from 1944 to 1948 by A. M. Kellam and his associates and originally reported by A. M. Kellam.

struction is to make line and chambers coaxial. Two such units were fabricated for test, the smaller of which is shown in Figure 5. Stewart filters, originally developed for use with air-borne sounds, have low-pass action, i.e., they convey sounds of all frequencies below a certain value, but (nominally) none above that value, which is determined mainly by the size and spacing of the chambers and the acoustic velocity in the medium. This idea was carried over into the hydraulic field by appropriate calculations, which were sustained by tests of the experimental models.

The larger filter yielded 95 to 99 per cent amplitude attenuation. It had a cut-off frequency of about 50 cps, obtained simply on a chamber volume basis; the large size of the filter was intended only for preliminary tests.

The smaller of the early two filters is of more interest because it was the first effort to make a low-pass filter of a size (2¾ in OD x 9 in long) which might be considered for aircraft use. The basic problem was to reconcile the contradictory requirements of small size and low cut-off frequency. Tests on this unit were largely unsuccessful.

A third and last Stewart filter was then made—a three-chamber unit, 4¾ in OD x 13 in long, designed for a particular airplane hydraulic system. Energy attenuation was about 90 per cent as measured by mock-up tests and designed cut-off frequency was 385 cps, about 70 per cent of the system fundamental pump frequency.

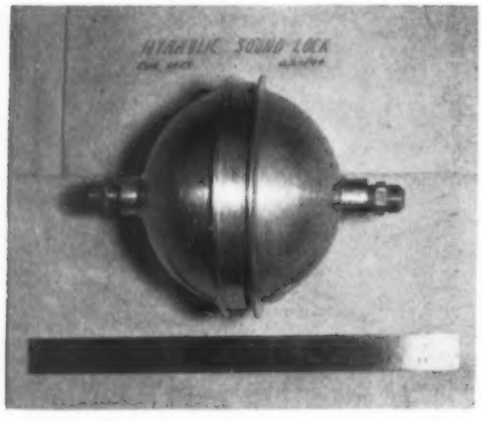

Fig. 4. Concentric sphere reflection attenuator or "hydraulic sound lock" rejects sound energy externally by successive reflections. A fair degree of attenuation was obtained at low frequencies (to 160 cps).

The conclusion drawn from the Stewart filter experiments was that the simplicity and fair performance of such a device does not overcome the objection to its practically irreducible bulk and weight.

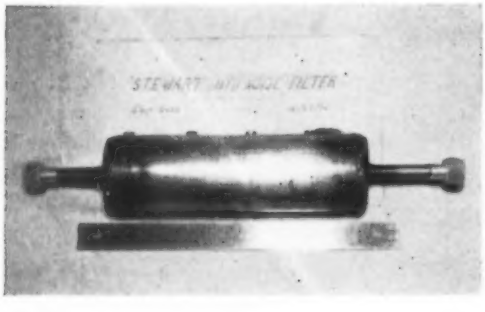

Fig. 5. The smaller of two early Stewart hydraulic noise filters. This prototype design for aviation hydraulic system use was not satisfactory in use.

Exponential Horns

While a horn seems like a poor way to suppress noise, its transmission efficiency varies widely and systematically with frequency. Horns in which section area increases exponentially with axial length may be shown to have theoretically zero transmission for frequencies below a figure, depending on flare rate (the exponent) and the acoustic medium. Actually, some energy passes through the horn material itself, but as a definite acoustic channel, the exponential horn does behave like a high-pass filter.

Two sets of horns were designed for different critical or cut-off frequencies and were installed singly or in series in a casing of suitable strength. The assembly and a sample of each horn is shown in Figure 6. This filter, and its various minor modifications, was tested in an airplane hydraulic mock-up, as well as in a small test circuit. Both systems ran at a fixed frequency. About the only variable was incident wave energy, of which the rough limits of pressure amplitude only were noted, since the effects of its wide variation were of more practical importance. Wave amplitude was varied either by altering pump discharge pressure or by reducing reservoir pressure until pump cavitation began.

A series array of horns was set up. The first set of four horns had a length of 2 in, with a 0.50 in inlet and 1.25 in outlet diameter. The corresponding flare index (k) was 0.458, giving frequency cut-off (fc) of 2750 cps. While encouraging results were obtained (total suppression of the fundamental (539 cps) and 96 per cent overall energy blocking), the results indicated that one horn was nearly as good as four, that diaphragms damaged performance and that the simple filter cavity (11.7 cu in volume), with no horns, gave considerable attenuation.

To determine whether an increased flare rate was desirable, a new set of 5 horns was made. Such a change would shorten the horn, raise the cut-off frequency and generally make for a smaller unit. Too much flare would lead to spherical wave propagation and loss of the horn's essential properties. Each of the new horns was 1 in long and with IDs of 0.50 in inlet and 1.14 in outlet (k was 0.784, giving an fc of

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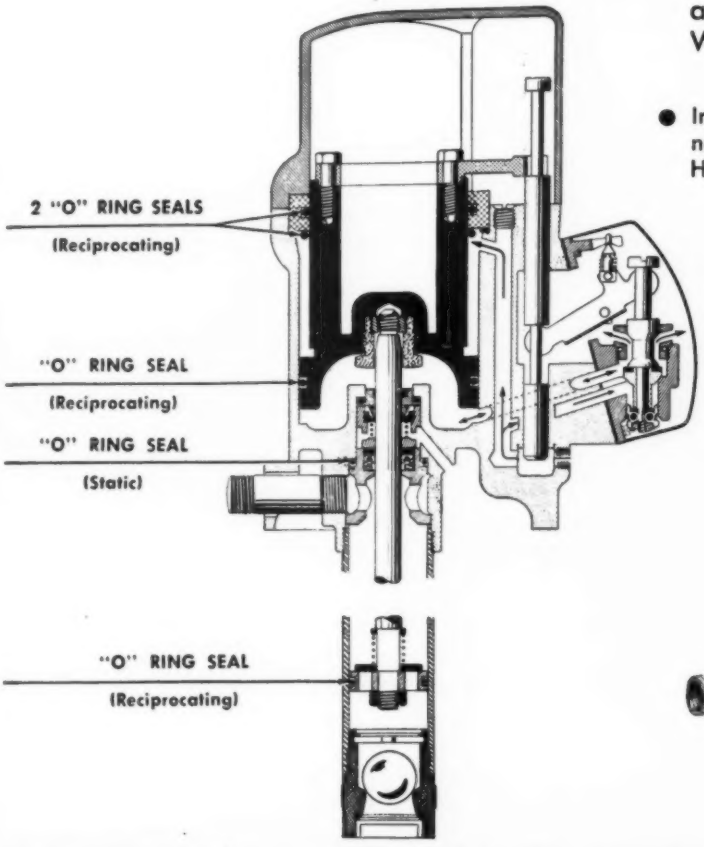

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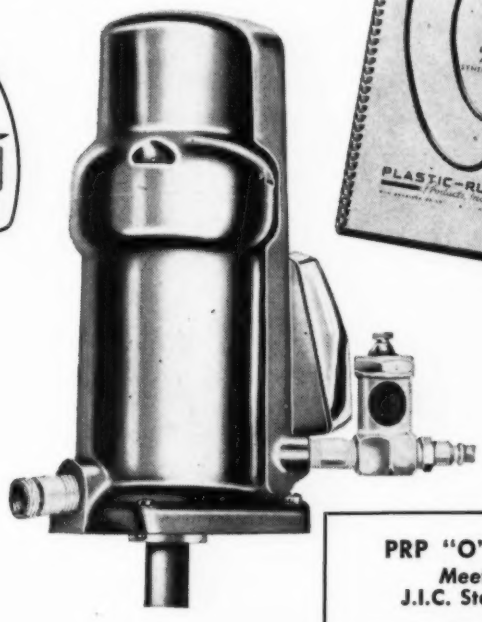

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4750 cps). The construction was simple and light but performance was disappointing: energy reduction was 79 per cent with one horn and 81 per cent with no horns.

The fact that best results were obtained with no horns at all was sufficient evidence that the horns installed were totally inactive. The longer horn, at least, had already proved itself in another filter body. An explanation may be surmised in terms of these facts:

(a) The connection between the line and horn inlet must be acoustically tight; even a small leak will short-circuit the horn by putting the capacitance of the whole filter body cavity in parallel with the horn. This explains why more than one horn is hardly worthwhile.

(b) The new filter body had a cavity volume of about 5.5 cu in, less than half that of the original. Theoretically, the size of the cavity following the horn has nothing to do with the latter's performance in the frequency range below cut-off, but the cavity has a great deal to do with the suppression of extraneous energy leakage past the horn. The importance of cavity design to the practical functioning of exponential horn filters was both indicated in these tests and confirmed later. There remains the conclusion that the prototype airplane filter had a satisfactory horn design but was too drastically reduced in size.

Fig. 6. One of the early horn filter unit with examples of horns designed for different cut-off frequencies.

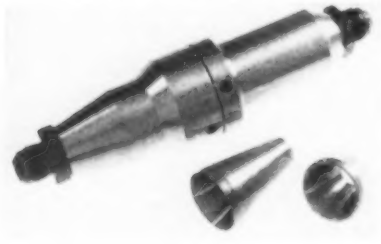

Fig. 7. An experimental line chamber, modified from a 5 in. accumulator to put the accumulator in parallel with the line without disturbing the diaphragm. This was the most effective line device tested.

About this time, a leading manufacturer marketed a similar device, some of which are now in use on various aircraft hydraulic systems. This horn filter was put through many tests including measurement of pulse amplitude change across the unit and tests at various frequencies. Results indicate that energy filtration improved with rising frequency, an unmistakable sign of capacitance loading of the line or simple cavity effect. When horns were tested in a small enclosure, the output amplitude and wave form indicated that considerable energy was retained by the higher orders of frequency. But when a cavity was added after the horn, the resulting improvement was not damaged materially by removing the horn, even though the horn was known to filter some of the lower frequencies. The conclusion was that money and metal were better invested in a small tank in the line than in horn devices.

Local Line Reactance Loading

This is a method both simple and effective in checking wave propagation. It makes use of a chamber located *in* the line. This unit must be designed to make use of the elasticity of the fluid in such a way as to cause a phase separation of the motion and pressure changes which are induced by the pressure wave.

Consider a pressure wave to enter such a chamber, with the main line continuing out of another port. The ensuing action will be the expenditure of wave energy in some combination of chamber oil compression and pipe oil acceleration (and compression).

Ultimately, actual attenuation must occur in the chamber, else the intensity therein would rise to a degree giving unimpaired transmission down the line. The size, shape and nature of the chamber walls all affect the results to the extent they affect absorption and successive reflection. Whatever these characteristics are in a given case, sound intensity in the chamber will rise until energy rejection is in equilibrium with the source; it is the equilibrium pressure amplitude which is transmitted downstream.

Figure 7 shows a line chamber consisting of a 5 in hydraulic accumulator modified to put it in parallel with the line without disturbing the elastic diaphragm. This was the most effective line device tested; at 200 cps energy diversion approached 97 per cent, while at 480 cps, outlet amplitude was immeasurable.

It is unlikely that resonance of the chamber would be a problem in such an application. The high inertance of the system would effectively block the outlet port and so the neck of the resonator would consist of the tube connecting pump and chamber. Even if as closely coupled as engine motion allowed, a chamber volume sufficient to function well would give the resonator frequency well below that of the pump noise. On the other hand, resonator overtones are so high as to lie above the probable range of exciting frequencies. Finally, the practical place to mount such a chamber is, for most airplanes, just aft of the firewall, which would give satisfactory reduction of critical frequency.

A similar device has also been developed independently by the Douglas Aircraft Company and is now in use in several of their multi-engine aircraft hydraulic systems.

Conclusions

The research work outlined briefly in the two parts of this article may be considered to have yielded a number of important conclusions, many of which have since been decisively proved by similar developments now in hydraulic system use. These conclusions may be summarized as follows:

1. The source of investigated noise lies within the system pump (or motor) and the noise fundamentally is due to abrupt pressure changes as the

(Continued on page 44)

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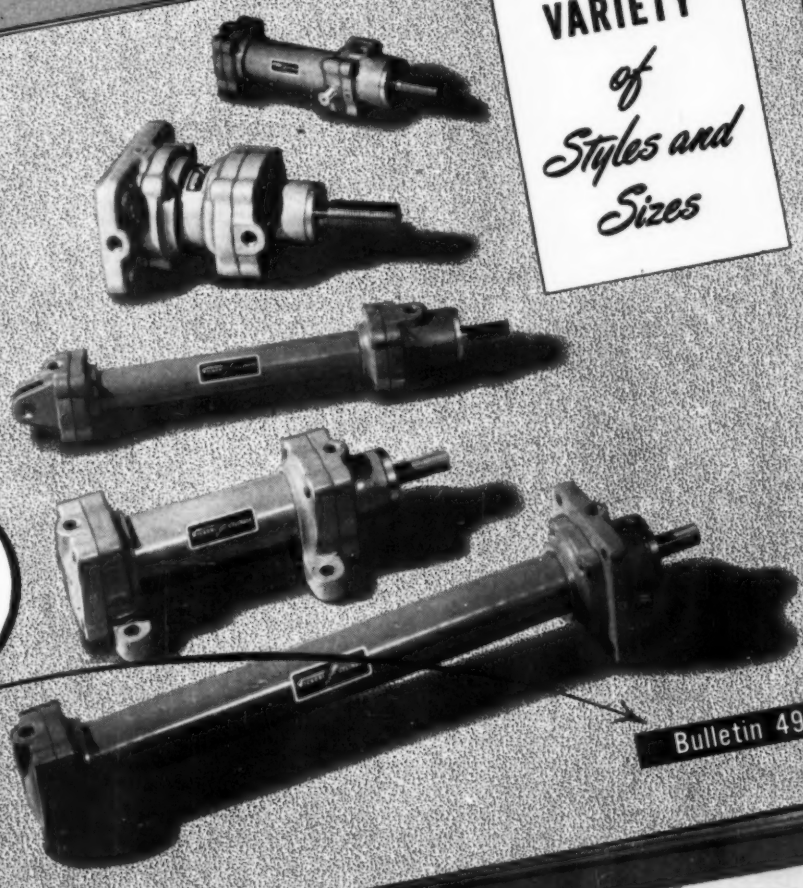

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COMPRESSING SPRINGS

(Continued from page 13)

longer depressed, the ram will remain in position until the emergency return button is depressed.

When it is desired to compress springs solid the cycle button is used. This is the fourth button located on the push button station. Momentary contact of this button will cause the ram to move until either the pressure switch causes reversal, the emergency return button is depressed, or until the spring pressure equals oil pressure in the hydraulic circuit.

The amount of ram pressure exerted on the spring or springs is controlled by the adjustable relief valve located on the control panel between pressure switches No. 1 and No. 2. The valve handle is turned clockwise until the spring coils close solid. This increases oil pressure in the cylinder, exerting more ram pressure.

With a spring or springs compressed solid, the pressure is read on the top gauge on the control panel. This pressure indicates which pressure switch should be selected for continuous operation. After selecting the proper range, the selector switch is positioned to that range, either one, two or three (pressure ranges 0-15 psi, 0-300 psi, 0-1000 psi). The valve directly over the pressure switch range selected is then opened and the pressure switch is adjusted to trip at the pressure previously set by the adjustable relief valve. This will cause the ram to automatically reverse and return to its starting position.

The machine is now set up for repetitive compressing. To unload the springs, the operator opens the tail stock hinge, swings the mandrel out and pushes the springs off.

	Specifications			H. S. Co. Compressor	Other Methods
	H	OD	d	Std Min/Pc	Std Min/Pc
a	1.750	.754	.156	.065	.091
b	.952	.718	.156	.064	.077
c	22.000	1.594	.187	.272	.316
d	2.000	1.012	.225	.076	.097
e	1.760	.854	.125	.055	.074
f	9.062	1.700	.093	.160	.192
h	4.312	.876	.203	.123	.138
i	.986	.794	.112	.067	.075

Table 1. Compression times for typical springs, showing improvement in time in minutes per piece.

Circuit Diagrams

As the tail stock is closed, the tail stock cam, Figure 4, in locked position closes LS1; when tail stock hinge is closed, LS2 closes; when the cover over the spring is closed, LS3 closes. All three LS must be closed to permit the machine to operate.

When the operator presses the cycle or jog button, the electrical circuit is closed, causing the solenoid valve to deliver oil to the rod end of the hydraulic cylinder which compresses the springs.

Springs are compressed until the oil pressure builds up to the pressure previously set on the adjustable relief valve and pressure switch.

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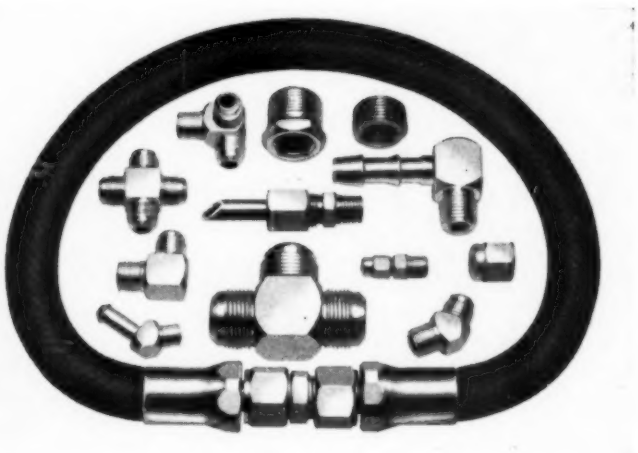

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When ram pressure equals manually set pressure, the pressure switches close another electrical circuit (Figure 7), which directs flow of oil to the blind end of the cylinder, releasing pressure on the springs and reverses movement of the ram until the ram contacts LS5 (Figure 5). This completes the cycle.

The electrical control panel, Figure 8 and diagram of the circuit, Figure 7, show the clean simplicity of the electrical system designed to operate the spring compressing machine.

Table 1 is an analysis made by our Methods Department to show in terms of standards in minutes the gain in production made with our hydraulic spring compressor. The actual range of time gains range up to 30 percent. To this production gain must be added the advantage of multiple spring compressing at one cycle since the entire mandrel length can be loaded, the number of springs compressed at one time depending on the extended length of the springs when loaded.

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CORRECTION

We are sorry that the captions for Figures 4 and 5 for Mr. Richolt's "Development of the Constellation Flight Control Booster System", published in the December issue, were transposed. It is obvious to those who read the article that Figure 4 caption should have been used with Figure 5 and vice versa.

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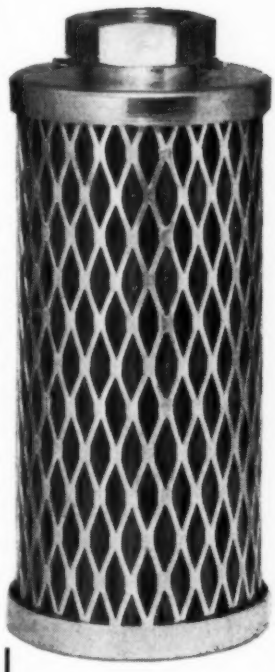

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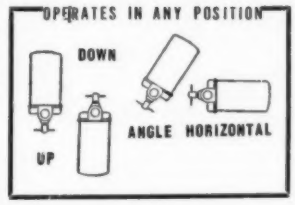

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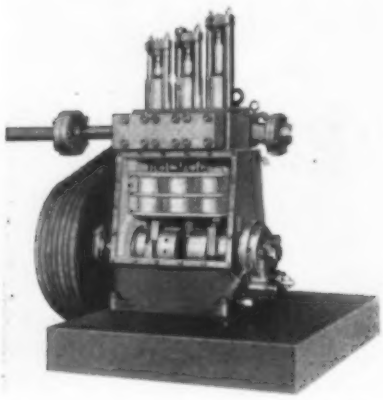

announced by The Aldrich Pump Company. The entire pump is designed for low maintenance and easy accessibility.

In the direct flow pumps, as in all Aldrich pumps with inverted design, the stuffing boxes are located at the top of the pump. The fluid end is sectionalized, the separate units include the working barrel, stuffing boxes, suction manifold and valve units. The valve assemblies including valve seats, held together by the manifolding, are also easily accessible. Removable stuffing boxes permit other size plungers to be adapted to the pump; two sizes of fluid-ends available permit the use of plungers ranging from 1¾ in dia to and including 3½ in dia. Aldrich "Kosmos" porcelain plungers can be used within this range of plunger sizes. The new series includes a Triplex pump, a Quintuplex, a Septuplex and a Nonuplex, respectively 3, 5, 7 and 9 cylinders, with hp ratings from 100 hp with the Triplex to 275 hp with the Nonuplex. *1.*

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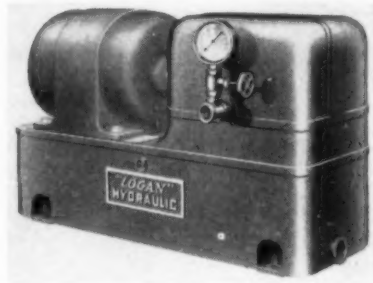

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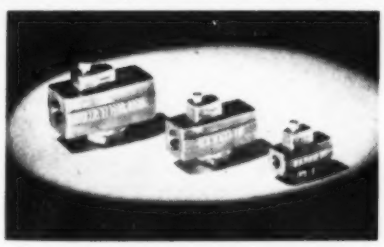

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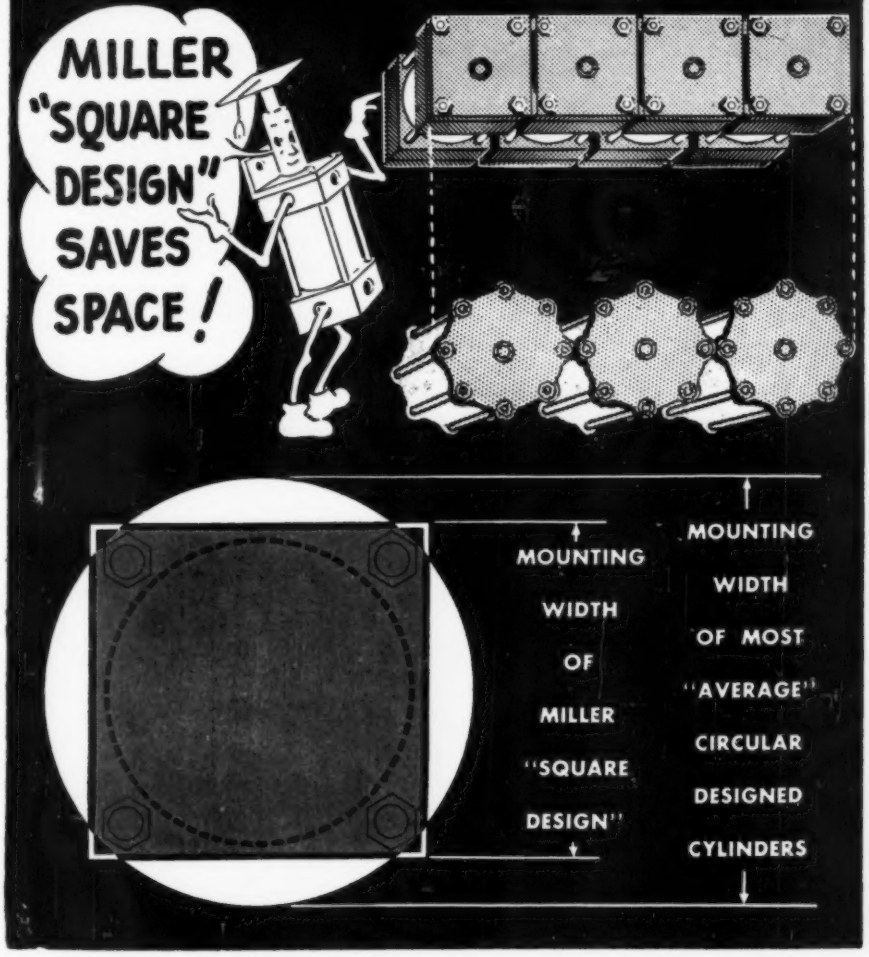
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Miller Air Cylinder Bulletin A-105 and Miller Hydraulic Cylinder Bulletin H-104

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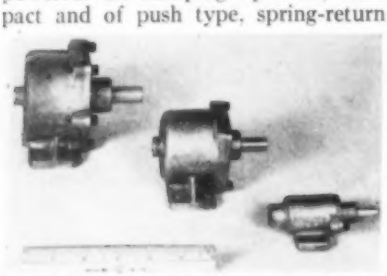
AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS • COUNTERBALANCE CYLINDERS • BOOSTERS • AIR HOISTS

eration. Connections are make or break by hand—no tools are required. Unions are available in sizes ⅛ to 1 in I.P. in steel for hydraulic and in brass for other services. *6.*

Air-Clamping Cylinders

A. Schrader's Son Division, Scovill Manufacturing Co. announces a new, complete line of bantam sized cylinders for industrial applications. A small, powerful air-clamping cylinder, compact and of push type, spring-return,



finds many and varied uses. Two styles, now available, permit easy installations in vertical or horizontal mounting positions. The cylinders come in bore sizes of 1, 2¼ and 3 in. with one and two in stroke lengths. When used as a clamp, they reduce operating costs and speed production by drastically reducing time normally used in manually setting mechanical clamps. A companion bantam size three way valve, to operate the air cylinders, was introduced at the same time. Of sliding disc design, a lapped stainless steel disc slides on a bronze ring, assuring air-tight sealing action. *7.*

Liquid Line Filters

The Marvel synclinal filter is now available in housings for line installations, in the new Model "SL" filters just announced by Marvel Engineering Company. The "SL" filter is expected to have a great many applications on O.E.M. where design has not made arrangements for a filter installation in the base of the reservoir, where reservoirs are too small for a standard sump filter installation and for hydraulic conversion jobs. The "SL" line can be used to filter oil or other non-corrosive liquids in low pressure pipe lines and where it is imperative that foreign matter be filtered out. The filters may be set in any position, giving flexibility to the necessary clearance space for cleaning

and are furnished with standard 100 mesh wire cloth. Other gauges from 30 to 200 mesh can be supplied. Six sizes with filtering areas from 56 to 340 sq in are available for pipe sizes ¾ to 2 in. *8.*

Rotary Solenoid

Two new rotary solenoids announced by G. H. Leland, Inc. for heavy duty service are compact and develop unusual torques for their size and weight.

The Ledux No. 7, is 2¾ in in dia, weighs less than two and a half pounds and produces a starting torque of 25 lb-in with a 45 degree rotary stroke; the Ledux No. 8 is 3⅜ in dia, weighs slightly over 4 pounds and develops a starting torque of 50 lb-in. A dustproof cover, a self-contained scroll-type return spring and other extras are optional to permit adaptability to a variety of applications. *9.*

VALVAIR- has an Air Control Valve
... FOR EVERY AIR CONTROL NEED

Adaptability, efficiency and dependability are had with "Valvairs" because of their many exclusive features. The unique "OU" type packer seals more effectively and lasts longer. No metal seats. Standard pipe area through the valve permits unrestricted air flow and prevents pressure loss. Flexible design allows virtually any desired control assembly. Rely on and profit by operation with "Valvairs".

★ ★ ★

Lever-operated, 3-way piped exhaust valve illustrated.

The VALVAIR line includes cam-, knob-, clevis-, foot-, treadle-, cylinder-, diaphragm- and solenoid-operated air control valves.

For use with air, water or oil pressures up to 175 lbs. p.s.i. and temperatures up to 120°F. 2-way; 3-way and 4-way open-end exhaust; 3-way and 4-way piped exhaust.

Sizes: ¼", ⅜", ½", ¾", 1"

Ask for Folder "A-H"

VALVAIR CORPORATION • 454 Morgan Avenue, Akron 11, Ohio
AFFILIATE: SINCLAIR-COLLINS VALVE CO.

Rely Upon Valvair — 2-WAY — 3-WAY — 4-WAY

Continental *plastics* USES
HONAN-CRANE for HYDRAULIC OILS

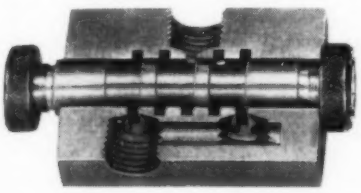
Continental Plastics Corporation, Chicago, uses Honan-Crane oil purification equipment on each Reed-Prentice injection molding press.

The continuous removal of all contamination (dirt, acids, varnish and sludge) protects the pumps, valve parts and other precision parts of hydraulic system. Excessive press maintenance and down time is eliminated.

For full information on low cost purification and maintenance of hydraulic oils, write to Honan-Crane Corporation, 102 Wabash Avenue, Lebanon, Ind., subsidiary of Houdaille-Hershey Corporation.

Air Control Valve

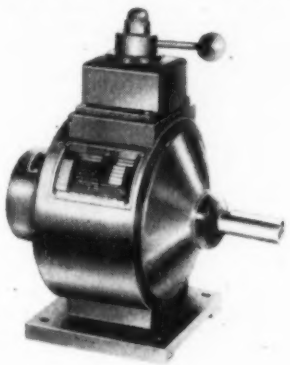
The Beckett-Harcum Co. announces the development of the revolutionary Hi-Cyclic air valve, designed to provide accurate, fast and smooth control of air power. In addition to the same functions of any operating valve, this valve will



control the stroke of an air cylinder within .001 in; stop and return the stroke at any point without overtravel; control the speed of stroke in either direction; reciprocate mechanically or electrically and control the pressure in both ends of the cylinder. The spool-type valve has a stainless steel piston, fitted to .0002 in; no packings or seals of any type are used. Intake air flows to both ends of the piston through dual pressure ports. Since pressure on the piston is equalized, the valve operates by a slight by-pass of lubricated air. With balanced operation, intake and exhaust of air is in direct ratio to the work load, giving maximum savings in air. Built-in directional speed control operated by turning stop nuts with micrometer threads provides positive speed control in either stroke direction. Model B basic valve is capable of 2500 cycles per minute as a reciprocating valve. Spring loaded and dual exhaust models, single and double solenoid, piloted and four-way hydraulic valves are also in the line. *10.*

Variable Control Pump

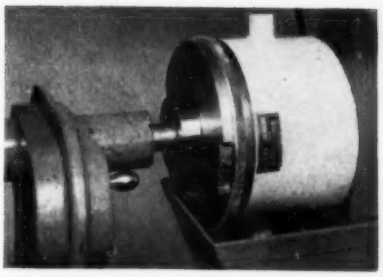
A new variable delivery model of their Junior Superdraulic pump is announced by Superdraulic Corporation. The Junior, with 6 gpm capacity at 5000 psi pressure, is ideally suited as a pulsation-free feed for production machines in the plastics, metal working and other industries, as well as in test operations. With the manual variable control, output can be regulated from 0 to 6 gpm for convenient control of machine operation without variation in



the motor speed. The overall dimensions of the new pump, including base, is only 11½ in x 10 in. It is available without the base for flange mounting. *11.*

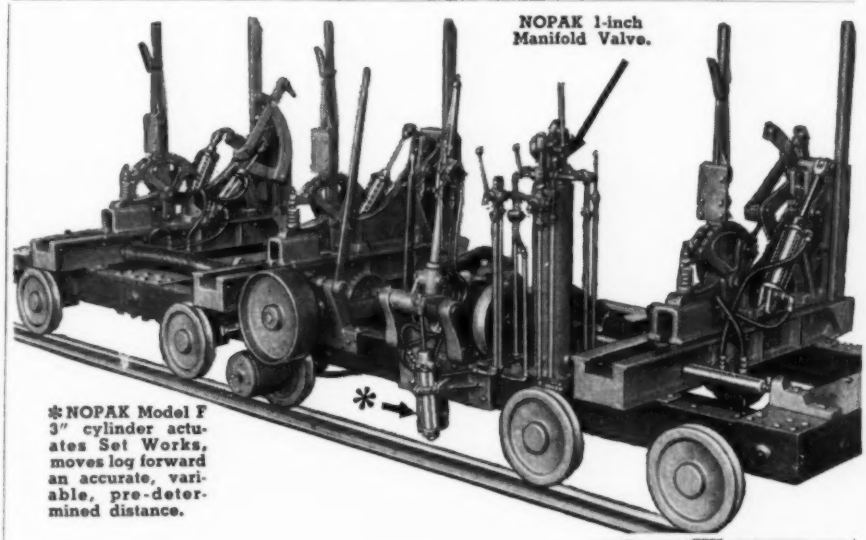
Dog Type Air Cylinder

A new air cylinder which uses the mechanical advantage of levers, or dogs, to give increased gripping power, has been marketed by Erickson Tools Division of Erickson Steel Co. The design enables the Erickson air cylinder to develop three or four times the drawbar force of a conventional air cylinder with the same piston area. The piston is of the "donut" type, permitting bar stock and work to be passed through the unit, which has a movement of ⅛ in in either direction and may be used



for either push or pull type mechanisms. It is particularly well adapted for oper-

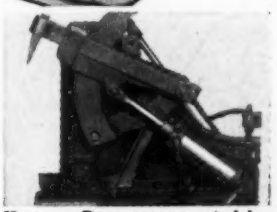
(Continued on page 35)



*NOPAK Model F 3" cylinder actuates Set Works, moves log forward an accurate, variable, pre-determined distance.

WHELAND LOG CARRIAGES Feature Bosses, Hammer Dogs and Set Works Operated by NOPAK Cylinders

A pioneer builder of sawmill equipment . . . the Wheland Company, Chattanooga, Tenn....recently converted its sawmill carriages from manual to air operation by the application of NOPAK Air Cylinders and Valves to certain machine movements. Mill operators report increased production, lower costs, better workmanship. Very likely the efficiency of machines which you build or use can be stepped up substantially through the correct use of NOPAK Valves and Cylinders . . . Air or Hydraulic. Write for NOPAK Application Manual.



Hammer Dogs are operated by 3" NOPAK Model E Air Cylinder for oscillating movement.

NOPAK Model E, 3" Air Cylinders are also used to actuate Air Boss Dogs as pictured here.

GALLAND-HENNING MFG. CO.
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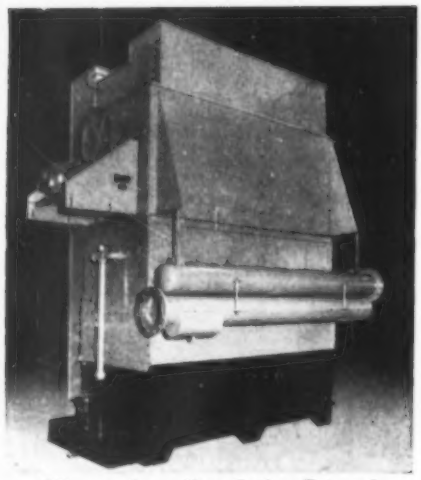


Niagara Aero After Cooler. Patented

How to PREVENT CONDENSATION in COMPRESSED AIR LINES

● Users of pneumatic tools and machinery spend thousands of dollars on repairs and suffer much interruption to production from the condensation of water in their air lines. In compressed gas systems and in processes where compressed air is blown directly on parts and materials in production, there is additional damage.

You can prevent these losses by installing a Niagara Aero After Cooler. It cools the compressed air or gas by evaporative cooling and removes the water before the air enters the receiver. This method brings the air to within a few degrees of the wet bulb temperature, making certain that your compressed air will always be colder than the atmosphere surrounding the lines in your plant, so that no further condensation can take place.

Savings in cooling water pay for the installation. Experience shows that the patented Niagara evaporative cooling method consumes less than 5% of the water required for cooling by conventional means. You save the cost of the water, the cost of pumping it, the cost of disposing of it. These extra savings soon pay for the Niagara Aero After Cooler.

Write for Bulletin No. 98

NIAGARA BLOWER COMPANY

Over 35 Years of Service in Industrial Air Engineering

Dept. AH, 405 Lexington Ave.
New York 17, N. Y.

District Engineers in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

BASIC HYDRAULICS

(Continued from page 18)

its bottom flush with the wall of the pipe. When the valve is closed, the gate blocks flow standing straight across the pipe, where it rests firmly against two seats extending around the pipe.

Gate valves permit straight flow and offer little or no resistance to the liquid when the valve is completely open. Although gate valves are often left partly open to throttle flow, they are intended primarily for full or no-flow use. If the valve is left partly open, its face may be eroded, since it will stand in the line of flow where the liquid can act on it. Gate valves are not easy to open or close if the pressure is high.

Globe valves. The globe valve, Figure 67, is somewhat similar in action to the gate valve. In the globe valve the controlling member of the valve, called the disc, is screwed directly on the end of the stem. The valve is closed by lowering the disc onto the valve seat. Since the liquid flows equally on all sides of the center of support when the valve is open, there is no unbalanced pressure on the disc to cause uneven wear and tear. Closure can be accomplished in a number of ways, e.g., by a sharply tapered plug, a ball, a plug with a 45 degree seat or a disc. The closure members is made of metal throughout and is regrindable while seated or replaceable when worn or it may be fitted with a renewable composition seat held in place by a nut. The taper of the plug, the depth of the tapered hole and the hardness of the material used at the seat will depend on the conditions of use.

Globe valves are frequently employed where passages are frequently opened and closed and for moderate pressures. While the globe valve offers more resistance to the flow of liquid than does a gate valve, it is, when properly piped, more easily opened and closed under pressure.

Flow must change direction when passing through a globe valve, but the valve can safely be kept in a partly open position to control volume of flow, since pressure is evenly distributed around the center of support of the valve. The valve should always be installed with pressure

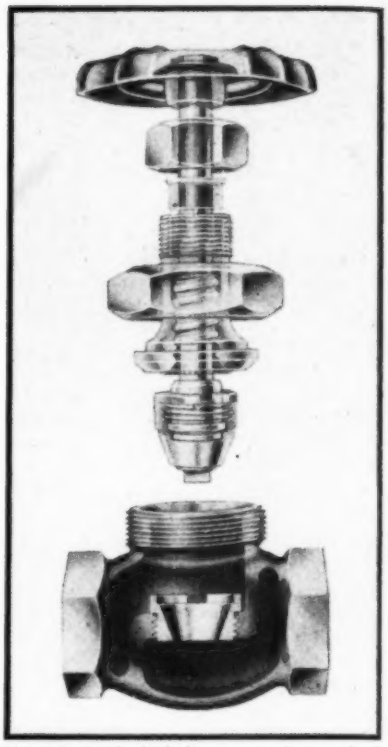
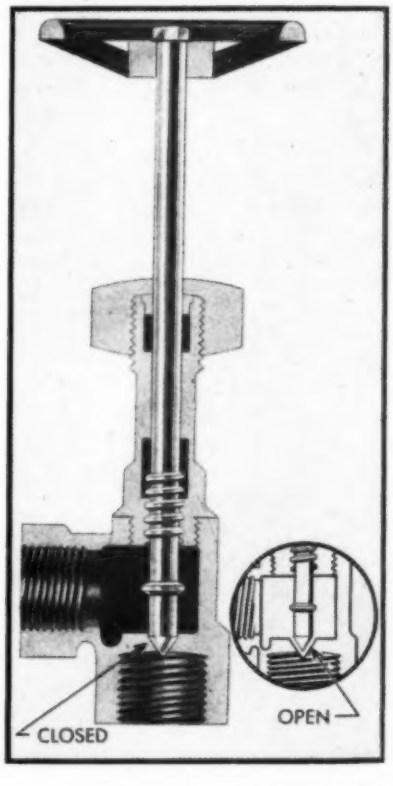


Fig. 67. Exploded diagram of a typical globe valve. The tapered disc is screwed onto the end of the stem.

against the face of the disc.

Needle valve. As the name implies, the needle valve has a long tapered point in place of a gate or the type of closing member used on the globe valve. The tapered point

Fig. 68. A needle type valve. The taper of the valve end and size of the open passage are designed for precise adjustments and low flow rates.



permits the valve to be opened or closed very gradually. This type of valve, shown in Figure 68, is used in gauge circuits; to control end operations of a work cycle, e.g., cylinder cushioning, where it is desirable to bring a work motion slowly to a halt; and at other points where precise adjustments of flow are necessary and where a small rate of flow is desired.

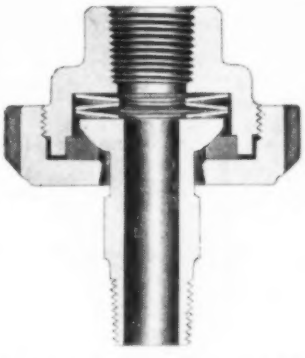
Chapter V is continued next month with a discussion of ball check type to include the check, relief, safety and automatic air vent valves and a discussion on the installation and maintenance of valves. Save this installment for future reference.

(Continued from page 33)

ating both collet chucks and expandable mandrels. *12.*

Rotary Swivel Joint

A new rotary swivel pipe joint for swivel and slow revolving applications is announced by Barco Manufacturing Co. The design eliminates wedge action of the ball against the gasket; turning torque is almost completely eliminated.



The ball is held in place by a Belleville spring. The new unit is unique in that a small amount of side flexibility reduces the possibility of wear or breakage from side strain. It performs without leakage at extreme temperatures and extra heavy models are available for extreme pressure and vacuums. It will handle practically all fluids and gases including corrosive acids and alkalis. *13.*

Hollow-Type Hydraulic Ram

A new hollow-type hydraulic ram of 10-ton capacity, designed for operation in the remotely controlled Porto-Power hydraulic unit they offer, is announced by Blackhawk Manufacturing Co. The new hollow ram—the RC-426—connects to the standard Porto-Power P-76 pump and Z-913 hose for operation of all new and existing knock-out punches in the field. At the same time the company announced four new Porto-Power knock-out punch assortments to cover a range of conduit sizes from ½ in to 4 in. *14.*

GREER ACCUMULATOR
Cuts Cost of This Machine $600.00, Reduces Its Weight 400 Lbs.

The accompanying illustration shows "The Bunell Completely Automatic Cylinder Trimming and Forming Machine" and two Greer Accumulators. The photograph is presented through the courtesy of the manufacturer, The Bunell Machine and Tool Co., Cleveland 14, Ohio.

"Using two 5-gallon Greer Accumulators in the hydraulic pumping unit of our completely Automatic Cylinder Trimming and Forming Machine we saved approximately $600.00 per unit cost and 50% of pumping unit floor space"— reports Mr. Victor S. Voigt, Chief Engineer and Sales Manager of the Bunell Machine and Tool Co. "The Greer Accumulators enabled us to use a smaller pumping unit thus making for a more compact and finer product with a saving of 400 lbs. in unit weight. In addition, using a simpler circuit we used fewer fittings and reduced maintenance to a minimum".

Redesigning your own process or machine to incorporate a Greer Accumulator, you too can cut unit cost, save floor space and increase production. Whichever way you use hydraulic power, a Greer Accumulator can help you do the job better, faster, more economically.

We at Greer are eager to discuss your particular hydraulic problem. A request for details on your company letterhead will bring an immediate reply. Write today.

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454 EIGHTEENTH ST., BROOKLYN 15, N. Y.

Useful Literature

The publications listed are available without charge. Mark the initial key number on the card bound in this issue and mail.

28. Facts About Hydraulic Oils . . . A bulletin just published by Hydraulic Equipment Company gives a fairly representative list of the products of the principal oil companies, together with technical data on their hydraulic oils that have been approved for Hydreco oil hydraulic systems. The bulletin also gives general facts about oils and their use in hydraulic systems.

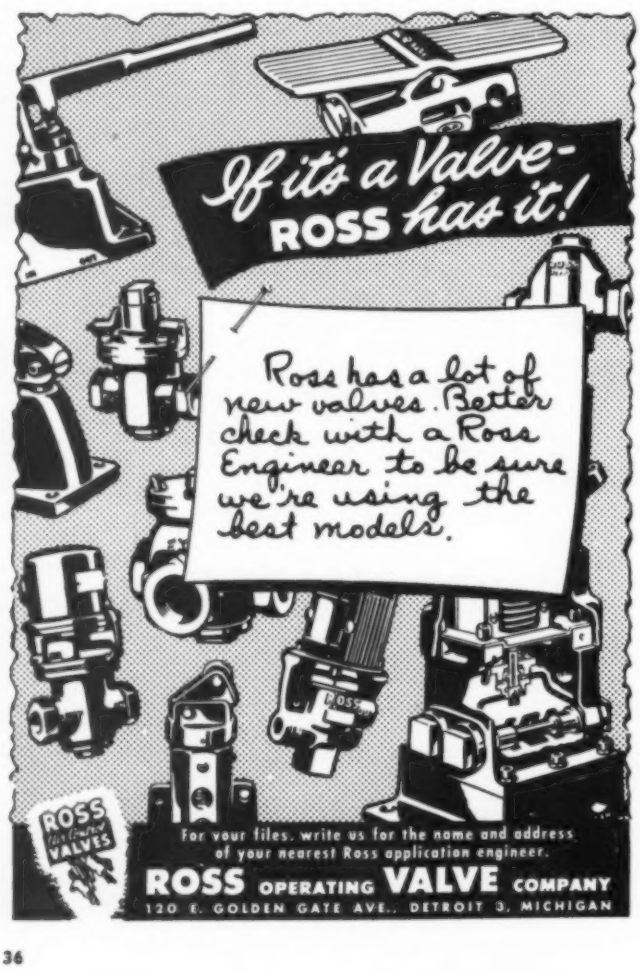
29. Pump Handbook . . . The Pesco Handybook, a 98-page manual on the hydraulic, fuel, fuel booster and air pumps, valves and other equipment made by Pesco Products Division, Borg-Warner Corporation, is now available for general distribution. In addition to pumps, hydraulic flow equalizers are shown; control and relief valves, superchargers, hydraulic motors and power packages are also included. A considerable number of handy engineering charts and tables (many conversion and equivalent tables), useful hydraulic formulae and others are shown.

30. Hydraulic Relief Valves . . . A new catalog, just issued by Fluid Controls, Inc., describes the pilot type oil relief valves made by this company. The valves are designed to operate with cracking pressure and reseating pressure greater than 90 percent of full relief pressure, permitting maximum relief pressure to be set at 10 percent over the normal working pressure. Pilot construction makes possible small size and light weight. Mounting brackets are not required in most applications. The valves are available in pipe sizes ¼ to ¾ in. adjustable to wide ranges of pressure to handle from 4 gpm at 500 psi to 28 gpm at 1000 psi. The manufacturer also shows manifolded and other types of relief valves.

31. Lubrication Guide . . . Swan-Finch Oil Corporation has issued a new 14-page lubrication guide, describing in detail the properties of the nine different Motul lubricants and giving recommendations for their most efficient use. Hydraulic oils; premium grade mildly detergent motor oils; Super Gyrol EP gear oils; heavy duty detergent type oils for high speed diesel and heavy duty gasoline engines; Upper Lube, a concentrated gasoline and diesel fuel oil additive; compounds and greases are included.

32. High Pressure Pumps . . . Berry Motors Inc. has issued a 20-page catalog, Bulletin 4912, describing the line of high pressure pumps and motors they manufacture. The unique positive displacement, rotary piston action of Berry hydraulic pumps, motors and transmissions is described and diagrammed and features are detailed. Series 1400 CH, "pancake" type reversible pump or motor is supplied with one, two or three pumps in a common housing, each unit capacity is up to 10 gpm at 3000 psi. A larger capacity Series 2000 CH pump or motor is furnished with single or double end shaft, the double fluid motor shaft divided at center to provide complete differential for tractive transmissions. Mounting data, parts lists and performance characteristics are shown. Similar data is included for a typical transmission and control valve.

33. Controlled Humidity . . . Bulletin 112, available from Niagara Blower Company, describes their Controlled Humidity Method of Air Conditioning. Hygrol, a hygienic absorbent liquid, is used to remove moisture directly from


If it's a Valve-
ROSS has it!
Ross has a lot of new valves. Better check with a Ross Engineer to be sure we're using the best models.
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AIR-MITE AIR ARBOR PRESSES

STAKING — RIVETING — MARKING — PUNCHING

Air or Spring Return

1 TON — ¾ TON — ½ TON — ¼ TON

A PRACTICAL range of sizes adaptable to an almost unlimited variety of uses in shop or factory. Air pressure can be regulated to give uniform pressure on each application . . . "just enough" effort to do the job without the danger of damage to the work, or the variations that may result from uncontrolled human effort. Ask for new catalog of Air-Mite Arbor Presses and complete line of single and double acting Air Cylinders.

AIR-MITE

2651-K West Lake St., Chicago 12, Ill.

the air. Installation setups and a flow diagram illustrating the operation of the system are shown.

CIRCLE NUMBERS ON THE CARD AND MAIL!

34. Air Clutches . . . The Fawick Airflex Co., Inc., full line of air actuated clutches is shown in their Bulletin 300. The sectional design clutch structure, tube flexibility for correcting misalignment and other design features of the Airflex Clutch are described and illustrated. Type CB clutches, the basic, general design; Type E, in which torque is transmitted from friction shoes to clutch housing by crossmember torque bars; and Type C, embodying the advantage of "free wheeling" operation at speeds higher than the functioning sped of the clutch and their elements are shown with specifications. The Fawick Power Take-Off Unit, close, gap and flywheel mounted assemblies are shown, as well as a quick release valve and three types of rotorseals. A method for selecting the correct element, service factors and horsepower ratings are included.

35. Hydraulic and Lubricating Equipment . . . An 8-page catalog, just issued by The Weinman Pump & Supply Co. features illustrations of a number of units which this company has designed and built for industry. Hydraulic "package" power units for large and small applications, lubrication pressure systems and components are shown.

36. "Products and Processes" . . . This booklet published by Union Carbide and Carbon Corporation, describes the principal activities of the five major Corporation groups—Alloys and Metals; Chemicals; Electrodes; Carbons and Batteries; Industrial Gases and Carbide; and Plastics. Short historical sketches trace the early years of some of the member companies. There is a products index. Brand names, details of processes and applications are given throughout the booklet.

37. Solenoid Operated Valves . . . Bulletin 8265, issued by Automatic Switch Co., is a condensed description of the "Asco" packless solenoid operated valves made by them. These general purpose extra heavy duty two-way shut-off valves are for applications not requiring full pipe area flow. They are suitable for handling air, water, light oil (70 SSU) and other liquids to 175 psi pressure. Design features are described and specifications are given.

38. Liquid Filters . . . An 8-page bulletin "Staynew Liquid Filters", published by Dollinger Corporation, shows the pressure type Model ELS and the sump type Model SE liquid filters made by this company. Design features, tables of sizes and general specifications and a partial list of the filtering media available for use with Staynew liquid filters are given.

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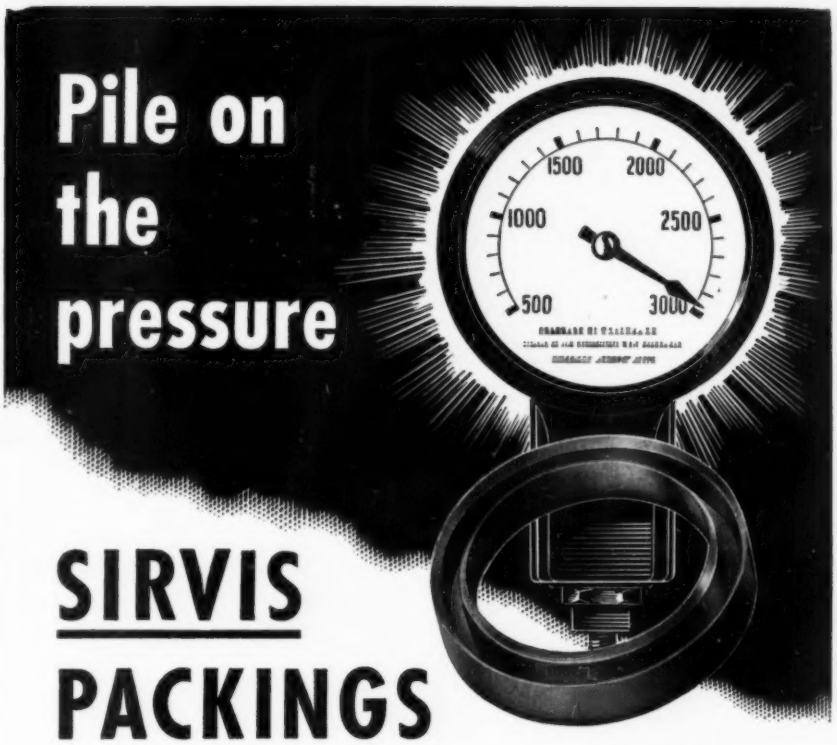

SIRVIS PACKINGS can take it!

Tough sealing jobs are all in a day's work for Sirvis packings. Extreme pressures . . . friction . . . the wearing action of hydraulic fluids, and other difficult operating conditions prove Sirvis' ability to take it. That's why Sirvis packings require less replacement than any other type. In many hydraulic applications, the cost of dismantling equipment and installing a new packing is often far greater than the cost of the packing itself. By assuring longer service, Sirvis hydraulic packings save you time, money and inconvenience. The next time you install or replace hydraulic packings, specify Sirvis.

- ***SIRVIS PACKINGS** are engineered from top grade steerhide, specially tanned and treated. They are scientifically designed for all types of mechanical applications.*

MECHANICAL LEATHER PRODUCTS

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NEEDS NO SEALING COMPOUND

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DRYSEAL
THREAD
PRESSURE PLUG

. . . seals pressure-tight without the use of sealing compounds. Features the "Dryseal" Pipe Thread originally developed for use with SO_2, ammonia, and other refrigerants. Offers a valuable solution to leakage problems in high pressure equipment of all kinds.

Unique design of the "Dryseal" Thread provides actual crushing and sealing at both major and minor diameters, effectively preventing spiral leakage, even under extreme pressures.

Incorporates all the important features of the regular UNBRAKO Pressure Plug, including fully formed threads, uniform taper and perfect roundness.

A full range of sizes from 1/16" ot 1¼", National Pipe Thread Fuel, is available.

Full details are given in Bulletin 675.

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STANDARD PRESSED STEEL CO.

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(Continued from preceding page)

39. Pressure Seals . . . Bulletin No. 6, published by Sealol Corporation, gives full data on the Series 30,000 face type mechanical seals for rotating shafts. The Sealol principle in which fluid pressure acts on the area differential of two opposing surfaces to insure proper seal face engagement is described and shown schematically. The "balanced pressure" feature, eliminating the necessity of heavy spring loading as well as controlling seal face pressure within safe limits is described. The Sealol numbering system, typical installation diagrams and brief data on the "Sealol CB", a complete mechanical seal, and "Sealol MM", an oil or grease retainer, are also included.

CIRCLE NUMBERS ON THE CARD AND MAIL!

40. Solenoid Valves . . . Bulletin No. S-1, published by Davis Regulator Co., describes the single seated, pilot operated, four-way, balanced disc pilot, two-step and other types offered by them. List prices are shown with specifications. The bulletin contains a reprint of an article on a plant in which the piping system was completely controlled by Davis valves.

41. Linear Actuator . . . The new improved model Lineator, an electrically operated linear actuator, is described in a 4-page bulletin issued by Airborne accessories Corporation. The Lineator A, or motorized screw jack, imparts straight line force in either tension or compression and may be employed in aircraft or industrial applications wherever straight line motion is required, e.g., position control surfaces, elevate rolls, regulate adjustments, etc. Both design and performance specifications are given.

42. Swivel Joints . . . Catalog No. 50, issued by Chiksan Company, devotes its 44 pages to descriptions and illustrations of over 500 different types and sizes of ball-bearing swivel joints. There are seven basic types for temperatures and pressures from minus 25 F to 600 F and from vacuum to 15,000 psi. Packing units, replacement parts and service instructions are given. Range of sizes is from ⅜ to 12 in.

43. Portable Compressors . . . The Campbell-Hausfeld Co. shows their line of four cylinder portable air compressors in a four-page bulletin, now available. Construction features, specifications are given for six models.

44. Hydraulic Weighing Cells . . . A new 8-page bulletin, No. 288, describes and profusely illustrates the Emery hydraulic cells for general industrial weighing and special laboratory testing equipment offered by the Testing Equipment Department, The Baldwin Locomotive Works. Six standard models, ranging in capacity from 10,000 to 100,000 pounds, and special cells with load

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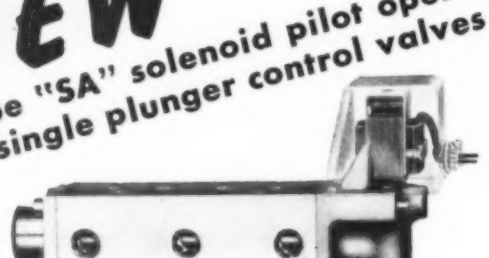

▶smaller, shorter stroke solenoids — lower amperage
▶simpler electrical controls — high air economy . . .

● Small solenoids traveling through only a ⅛" stroke move a small pilot valve plunger to apply air to the operating piston to move the main valve plunger. All operating parts are rugged, yet weigh only a few ounces. Reduced amperage eliminates intermediate relays, simplifying control circuits. Positive high cycle operation, without destructive impact, reduces maintenance and minimizes trouble due to voltage variations. 2, 3, 4 and 5-way designs. ⅜" to 1" sizes, with bucking cylinder return.

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Each year passed has added to our own extensive store of hydraulic know-how.

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HUFFORD HYDRAULICS

capacities from 40 pounds to 2500 tons are described. Also described are three self-contained, portable weighing units or scales with Bourdon tube indicators and cell applications of the Tate-Emery indicator. The principles of operation of the Emery cell and the Tate-Emery indicator are schematically described and illustrated.

45. Chevron Packing . . . A six page folder, Form No. AD115, issued by The Garlock Packing Company, describes and illustrates typical assemblies of Garlock Chevron Packing. Furnished in ring form only, there are grades for all types of industrial service. Garlock 7857 Chevron is designed for heavy hydraulic service against oil or water; Garlock 430 Chevron is designed for rams or plungers for hot or cold water heavy-duty hydraulic service.

46. Air Line Fittings . . . Catalog No. 49 issued by The United States Air Compressor Co. shows the complete line of Bowes couplings, pressure seated air valves, fittings, hose, strainers and oilers, blow and spray guns and other accessories for air line service.

47. Switches and Timers . . . Catalog No. 1010, issued by Sangamo Electric Company, lists all of the standard types of time switches and timers made by this company. These include three miniature time switches, two types of interval timers, two types of heavy duty synchronous time switches (available in a large variety of cases), two-circuit and duplex time switches and other special duty units. Connection diagrams are also shown.

48. Impulse Timer . . . A new catalog sheet, just issued, shows the improved Model RT impulse timer made by Zenith Electric Co. The timer, without gears and clutch, is recommended for production line control, pilot circuit and other timing, mixing and molding machinery and other industrial uses.

49. Compressor Selector . . . Quincy Compressor Co. is offering a compressor selector slide rule with which cfm of air delivery desired, the Quincy model air compressor, hp, speed and piston displacement may be read by setting any pressures from 30 to 250 or vice versa.

New Short Course In Oil Hydraulics

The Evening and Extension Division, Rochester Institute of Technology, Rochester, N. Y. announces a new course in industrial oil hydraulics, two evenings each week, for the 15 week period beginning January 31 to May 11. Designed for maintenance and service men, designers, draftsmen and engineers, the class will be instructed by Fenton Canfield, hydraulic specialist, Delco Appliance Division, General Motors Corporation.

BOOK REVIEWS

The Sealing Mechanism of Flexible Packings

C. M. White *and* **D. F. Denny,** *professor, Imperial College and representative, Ministry of Aircraft Production, respectively. 128 pages, 7⅜ x 9¾ inches. Published by His Majesty's Stationery Office as British Ministry of Supply Scientific and Technical Memorandum No. 3/47. Available in this country from British Information Service, 30 Rockefeller Plaza, New York 20, N. Y., at $3.15.*

This is a report of a comprehensive study into the fundamental behavior of flexible packings, principally those made from synthetic rubber. The report includes both data and discussion of results on tests dealing with the manner of sealing, modes of failure, nature of lubrication, measurements of friction and other factors about which little has been published and, in fact, little has been known. Most of the work was done on the rectangular section ring, commonly used in Britain, but studies are also included on "O" rings and "U" cups.

This report should prove invaluable to engineers who are constantly faced with new sealing problems and who need a more basic knowledge of packing behavior. Dealing with pressures up to 4000 psi, it covers a broad area of packing usage and should offer some new ideas and perhaps confirm the theories of those who have devoted much more than the average amount of time and study to this subject. Obviously, the work points the need for additional research into problems which are not answered completely in this study. It is hoped that further work, perhaps in this country, can be done to supplement this very excellent beginning made in Great Britain.

F.O.H.

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★ Hydraulic Cylinders for pressures to 1500 PSI
★ Ten standard bore sizes from 2" to 8" inclusive
★ Standard air cylinders for pressures to 150 PSI
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★ Twelve standard bore sizes from 2" to 12" inclusive
★ Cushioned or non-cushioned
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Write for Bulletin 700, "Hydraulic Cylinders," or Bulletin AC-2, "Air Cylinders"

LINDBERG AIR & HYDRAULIC CYLINDERS

HYDRAULIC SEALS

(Continued from page 20)

desired shape by heavy pressures running into thousands of psi, and that this pressure is not evenly distributed at first, so that cores or portions of the mold extending into the part must be of sufficient strength to withstand this pressure.

The properties of rubbers depend not only upon the base stock, i.e., Neoprene, Buna N, etc., but upon the compounding materials used. While compounds made of a given base have some general characteristics in common, literally thousands of compounds with widely varying characteristics can be made from a given base material. Compounds often use more than one base stock to get the desired properties. In picking proper stock or compound, it is important to consider the medium with which it comes in contact, the temperature, the shape of the part to be made from it, the pressure involved and the desired physical properties. If the designer knows all the conditions involved, he will usually be able to select a compound with these characteristics.

A piece of rubber can be noticeably changed in shape by the application of a relatively moderate force; the stress set up in the material by the force will return the piece to its original shape when the force is removed provided the stress is not too high. If the critical stress, which depends upon the compound, the time under stress, the temperature and other conditions, is exceeded, the piece will return only partially to the original shape when the force is removed. A similar phenomenon in metal is permanent set or plastic flow. The stress at which this occurs is not as definite in rubber as in metals and is difficult to determine. With a given piece of rubber and a given force applied, the amount of set increases with the temperature of the rubber and the length of time the force is applied.

The statement that rubber is incompressible is often surprising due to a misunderstanding of the definition. A material is compressible only if its volume can be changed by an applied force. This may be illustrated by considering the space between the closed end of a cylinder and a leak-proof piston completely filled with rubber. The piston could be moved only by the application of an extremely high compressive force. This force is greater than forces ordinarily encountered in hydraulic work; for most practical purposes rubber may be considered as incompressible. In this respect rubber is similar to a fluid, and at moderate pressures it acts as a fluid in the cylinder, the force on the piston creates a corresponding pressure in the material which acts to set up a uniformly distributed pressure on the confining walls. If these walls are thin enough to bulge under the pressure, there will be a corresponding change in shape of the material but practically no change in volume. If the piston had a slight clearance in the cylinder, sufficient force on the piston would cause the rubber to flow into the clearance space. This is a form of plastic flow called extrusion. Figure 4 illustrates the incompressibility and flow characteristics of rubber.

Since synthetic rubber is relatively non-porous as compared to leather, it usually has a high coefficient of friction and is subject to abrasion if not lubricated, so that in dynamic applications care should be exercised that lubrication is present; it is important that the piece be lubricated upon installation. In some installations where lubrication is sparse, a pre-lubrication is sufficient to prevent abrasion. Rubbers are not ordinarily recommended for temperatures exceeding 250 or 275 F when immersed in oil. Silastic rubbers have been developed which will stand higher temperatures, but they are lacking in other desirable properties and should be used only advisably.

Part 2, in which a number of types of seals are discussed and illustrated, will appear in an early issue.

HARVESTING ICE

(Continued from page 21)

nitely variable speeds, shockless operation and perfect control by even an inexperienced operator.

The Gay Engineering Company, working closely with a leading West Coast cylinder manufacturer, was able to accomplish this by a hydraulic system in which heavy duty cylinders provided the hoisting and cross travel motions.

The assembly consists of a balanced vane hydraulic pump direct coupled to a standard constant speed induction motor, two cylinders, their valves and operating means. The system pressure is approximately 1000 psi. The relief valve is a balanced piston type.

The cross travel cylinder is specially designed by Gay. It has two single acting pistons in a long tube, 3 in by 14 ft long, connected by a rack (Figure 2) which actuates a pinion at the center and just outside the tube, giving a stroke of 78 in.

This pinion actuates a grooved drum over which a wire rope is wrapped, both ends of which are fastened to the crane bridge. Reciprocating motion to the trolley is controlled by the simple movement of a single lever (Figure 2) of a four-way valve, with a standard closed center spool. The beginning of motion in either direction, the acceleration in infinite degrees to full speed, the deceleration, similarly, to full stop and the location at rest at any point are under complete and constant control of the crane operator.

The hoisting cylinder is a standard heavy duty, double acting hydraulic cylinder, 8 in in diameter with 42 in stroke. A twin flow control unit, standard metering in type, operated integrally by means of a tie bar and cable arrangement, has one flow control in the pump—four-way double solenoid operated valve line, the other between the piston rod end of the cylinder and the four-way valve. This valve is also a closed center type. A two-way solenoid valve is located in the line between the rod and cylinder piston ends.

The hoist can lift 13,000 pounds of ice from 0 to 16 fpm or lower the same load at a rate of 0 to 50 fpm. Trolley speeds can be controlled smoothly from 0 to 120 fpm; dumping speeds are controlled from fast to slow as required, all completely free of shock and impact loads.

The advantages of hydraulic power in the ice harvester have been summarized by Gay as: elimination of shock impact loads; smooth starting and stopping, infinitely variable speeds, operation and control by inexperienced personnel and practically no maintenance.

APPLIED HYDRAULICS DIGEST

Abstracts, summaries and listings of articles on hydraulic and associated applications in industry; reports on prepared papers, talk and discussions pertinent to the hydraulics field.

Hydraulic Packings For Industrial Equipment

J. N. Smith, *Machine Design,* v 21, December 1949, pp 155-160.

After a brief introduction which explains the standardization of hydraulic packings by the Joint Industry Conference on Hydraulic Standards for Industrial Equipment, recommended Dash Numbers for the five basic packing designs—U, V, Cup, Flange and "O" Ring—are given in tables of standard sizes. The packings represent one of the first projects outlined in the Hydraulic Standards to reach practically complete standard classification. Some details, e.g., the coding system details, stack height, stuffing box design and others, still remain to be worked out but the article indicates that the major job has been done.

Lubrication Service System

O. M. Albl, *Steel,* v 125, November 28, 1949, pp 60, 70, 86, 89.

An account of the operation of the lubrication department activities at the Thompson Products Inc., Cleveland plant. The set up of machine surveys, individual machine records, scheduling of actual lubrication maintenance, (average number of trips to individual machines was cut from 10 to 4 per year), the use of carts for tools and oil containers, the use of identification symbols for specific lubricants and the laboratory supervision system worked out are described. The program has resulted in standardized and simplified maintenance, savings in man hours, less oil cost and less downtime. The entire program and complete records covered 34 classifications of lubrication and over 700 types of machines.

A Century Of Apprentice Training

Anderson Ashburn, *American Machinist,* v 93, December 15, 1949, pp 75-77.

A brief review of the apprentice training program at Brown & Sharpe Manufacturing Co. Since Jos. R. Brown took on Lucian Sharpe as an apprentice in 1848 the apprenticeship program has been continuous, perhaps the oldest in industry and certainly the best known. Records show that of 1073 known living graduates, 55 per cent are now employed in some supervisory position, 26 per cent are employed as skilled craftsmen

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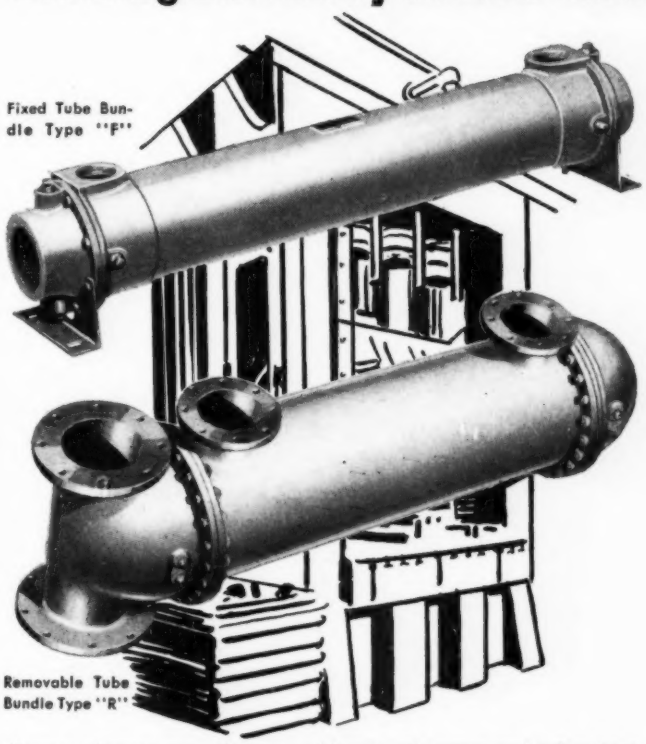

Young, pioneer manufacturer of heat exchangers and other heat transfer products, now offers greater savings in initial and maintenance costs with its newly designed heat exchanger line. Corrosion-resistant Admiralty tubing, larger tube sizes, and engineered tube spacing and baffling mean longer service, easier maintenance. Coupon brings full details, without obligation.

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Fire fighting equipment has to be 100% dependable. That's why "Sealol" was selected for the shaft seal in the motor that raises this Aerial Ladder.

JOB REQUIREMENTS:

Equipment: Delaval-Imo Hydraulic Motor manufactured by Delaval Steam Turbine Co. for American LaFrance Aerial Ladder.

Fluid: hydraulic oil SAE 10W

Fluid pressure: 1000 PSI

Shaft speed: 3500 RPM

Shaft diameter: 1 9/16"

Space limitations: diam. 2.250"; axial length .844"

Leakage allowance: none

SOLUTION:

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"Sealol" mating ring

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and 6 per cent are retired. Of all graduates since 1884, thirty per cent are still with the company. Of the normal group of 150 apprentices, 55 per cent are in the machinist course, 17 per cent are draftsmen, 10 per cent are moulders, 8 per cent wood and metal patternmakers and the remainder are distributed among the special training courses, such as coremaking and screw-machine operation. The article describes the normal procedure in the selection of boys; careful selection being essential in maintaining the exceptionally low drop-out rate and the high standards expected of the apprentices. Tables which give both the shop and school programs for the four years of machinists' program are included.

Self-Energizing Disk Brake

Anonymous, *Machine Design,* v 21, November 1949, pp 125, 126, 182.

A description of the new hydraulic automotive braking system introduced by Chrysler and now making its appearance on the Crown Imperial models and evaluated as "the first real major advance in automotive brake design". Advantages claimed for the self-energizing disk brake included: more braking effect and less pedal pressure for the same amount of braking, more successive high speed stops without noticeable increase in pedal pressure or reduction in braking effect, less pedal pressure when descending hill with continuous brake application and automatic self adjustment throughout the life of the linings. Basically, the design utilizes two 12-inch cast aluminum pressure plates in the form of annular rings inside a cast-iron brake

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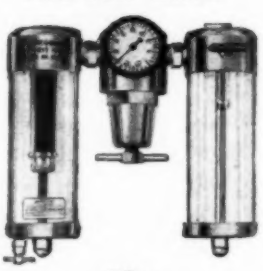

FILTER element removes solids .00039 and larger. TRANSPARENT BOWL provides visibility. REGULATOR is capable of passing large volume with an unrestricted flow and minimum amount of pressure drop. Self-bleeding, compact, simple. Machined from bar aluminum. LUBRICATOR delivers desired volume of oil. Adjustable Venturi Valve permits efficient operation on broad range of volume and pressure. Bowl can be refilled without shutting off air supply. Any of these 3 devices can be used as separate units or in any combination.

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housing. Braking is effected by moving the plates apart along the axis of the housing until the brake lining segments bonded to the outer surfaces of the plates contact the inside flat surfaces of the rotating housing. The contact is effected by movement of hydraulic cylinder push rods which force steel balls out of grooves, spreading the plates. Two identical units are mounted on each inner pressure plate diametrically opposed, compensating automatically for lining wear and maintaining full pedal effectiveness. To provide the desired ratio of braking effect between front and rear wheels, 1¼ in cylinders are used on the front brakes, 1 in on the rear. Four return coil springs are used in each brake assembly to pull pressure plates together when hydraulic pressure is released and to prevent the plates from dragging.

Non-Flammable Hydraulic Fluids

C. M. Murphy and **W. A. Zisman,** *Lubrication Engineering,* v 4, October 1949, pp 231-235 and December, 1949, pp 264-269.

This paper was presented at the 4th Annual Convention of A.S.L.E., New York City, April 12, 1949.

The properties required of hydraulic fluids are reviewed and the need for a less flammable fluid to take care of the fire hazards that are inherent in military and in some industrial applications is pointed out. The common flammability tests—spontaneous ignition temperature (S.I.T.), flash and fire points were found to be incapable of predicting the relative flammabilities of fluids to the varieties of fire hazards in service. Two

(Continued on page 46)

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Thrust plates, bearing plates, pressure plates, bushings, seals and connecting rods, machined or rough cast from

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Write for literature or let us quote you and make recommendations. You are invited to submit blueprints, conditions of operation and other data.

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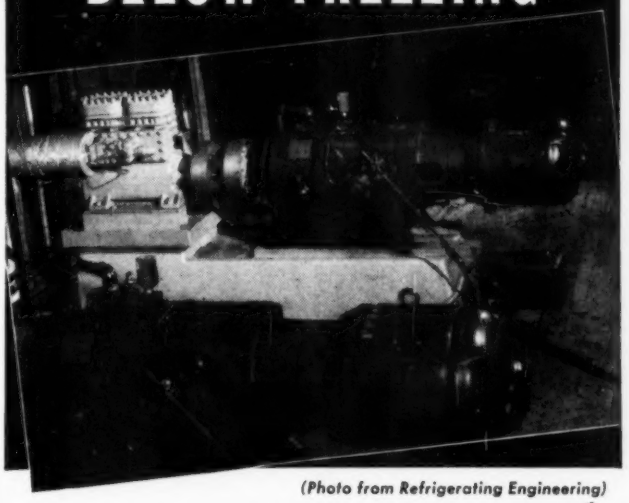

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OILGEAR *Fluid Power*

SOLVED THIS PROBLEM

The wide range of installations that demonstrate the reliability, scope and ease of control of Oilgear Fluid Power Drives and Transmissions grows daily. A case history from REFRIGERATING ENGINEERING, official journal of the American Society of Refrigerating Engineers, telling how a research laboratory chose Oilgear Transmissions and obtained continuous, dependable performance without delay, is another chapter in that story.

Demands for tests of materials at extreme temperatures called for equipment able to hold testing room temperatures stable at all times—usually at 70° F. below zero. It also had to refrigerate test materials as rapidly as possible. This meant a system of varying compressor speeds automatically—so as to compensate for variations in heat load.

Previous experience had shown that . . . the use of direct current motors, or variable speed drives of the belt-and-pulley type, under automatic control, was not entirely reliable and required considerable servicing.

Then Oilgear Fluid Power Transmissions were adopted. These transmissions provide continuously and automatically variable output speed and maximum output torque at all operating speeds. Nearly two years' experience reveals that temperatures have been maintained within ±½° F. of the desired figure over long periods of time, that no attendant is required except for a few minutes' daily routine inspection, that the Oilgear drives are completely reliable.

Thus the evidence grows that if you are tired of machine or process drives and transmissions that don't stand up, if you want simpler, better, more productive and dependable drives, if you have problems not yet solved, it will pay you to contact Oilgear Fluid Power engineers. THE OILGEAR COMPANY, 1564 W. Pierce St., Milwaukee 4, Wisconsin.

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PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

POST SCRIPTS OF INDUSTRY

NEWS · VIEWS · TRENDS

Robert Krepps has been appointed district sales supervisor of the midwest area for Denison Engineering Co. He will maintain offices at 11047 S. Hale St., Chicago, Ill.

The Brown & Sharpe Co. announces the opening of an office at 3040 East Olympic Blvd., Los Angeles 23, Calif. The new office will be under the direction of Thomas F. MacLaren. Victor S. Lindstrom, Lewis J. Smith and Howard A. Wood will be associated with him. Ralph P. Sharp and Frank K. Wilkey, also under the direction of Mr. MacLaren, will headquarter in San Francisco to serve customers in the central and northern sections of California.

The Elmes Engineering Division of American Steel Foundries announces removal of all departments from its location at 230 N. Morgan St., Chicago to a newly finished modern building at 1150 Tennessee Ave., Cincinnati, Ohio. The move was made necessary due to the increased demand for all types of Elmes hydraulic machinery products. In addition to machine tools the company makes air ballasted hydraulic accumulators and high pressure pumps and control valves.

John D. Baldwin, Jr., has been named chief engineer and John D. Smetzer as vice president in charge of industrial relations for the Weatherhead Company.

J. P. Cooper has been appointed headquarters sales manager; R. R. Stevens, industrial engineering manager; and A. J. Bent, field service manager of the newly formed Industrial Products Division of the Westinghouse Air Brake Company. These men will develop, promote and market all products of the company outside the railway field.

Donald L. McCollum has been appointed plant manager of the synthetic rubber plant operated by United States Rubber Company at Naugatuck, Conn. He has been with

HYDRAULIC NOISE

(Continued from page 26)

liquid passes through the device.

2. Noise intensity (energy) depends upon:
   a. Difference of squares of pressures across pump.
   b. Pump speed.
   c. Geometry or design of pumping mechanism.
   d. System liquid characteristics such as compressibility and air solubility.
   e. Extent of air entrainment (inlet cavitation).
3. Measured on an energy basis, 90 per cent of the noise may be eliminated at source by a simple design change on pumps or motors having a fixed or consistent valve action.
4. Acoustic filtration of 96 per cent noise energy is possible with apparatus of size and weight for airplane use.
5. A design change in pumps and motors to reduce pressure wave amplitude is the most direct solution and entails no additional weight.
6. If acoustic filtration is used instead, one unit per pump is recommended.
7. The best and simplest method for keeping waves out of the hydraulic system is an in-line chamber of correct size.

While it is acknowledged that the type and source of noise discussed here is not the only noise involved in hydraulic system operation, it is reasonable to assume that with proper system and component design, plus suitable filters where necessary, noise and vibration need no longer be a source of annoyance and destructive influence in operation of aircraft hydraulic systems.

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Rates: For "Positions Wanted" $4.00 minimum, limit 25 words. For all other classifications $4.50 minimum for 25 words, each additional word 15c; bold face type or all capitals, $7.50 minimum for 25 words, each additional word 20c; limit 50 words. Box addresses count as five words. All insertions are payable in advance.

These columns are limited to Help Wanted or Position Wanted ads, and offerings of used equipment by the users of such equipment.

Engineering sales representatives wanted in principal cities to handle complete, quality line of air and hydraulic cylinders. Write in confidence, stating lines now being handled, territory covered and references. Address Box 2150 APPLIED HYDRAULICS.

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Specializing in hydraulic, pneumatic, electrical control circuits. Schematic circuits, complete machine designs. Unbiased equipment recommendations. P. H. Winter, 109 Archer Road, Syracuse, N. Y.

Hydraulic Cylinders, Double acting, 2½" Bore, 16½" travel, 1 3/16" shaft, ¼" pipe thread ports, Brand New $11.00 each, plus transportation. Shipping weight 10 pounds. Discount on ten or more. Spencer Aircraft, 8410 Dallas, Seattle, Washington.

Hydraulic Units, Dynamometers and Test Stands (ready and useable for aircraft and equipment tests). Also Universal and General Hydraulic Test Stands complete with Vickers 2008 FHAA variable pumps, and 2305 AH pumps, flow meters, etc., driven by Louis-Allis 10 H.P. motors. Save 30-50% on complete unit, pumps, tanks or motors.
Pictures, prints, full descriptive literature sent upon request.
Box-41, Kensington Station, Detroit (24), Michigan.

the company for 30 years; during the war he was production superintendent of Pennsylvania Ordnance Works, Williamsport, Pa. and in 1945 was appointed factory manager at Naugatuck Chemical.

Ernest A. Berglund was elected vice president of Hydraulic Equipment Company, according to an announcement by Hall Kirkham, president. Mr. Berglund has been active in the industrial hydraulic field for many years; previous to joining the Hydraulic Equipment Company he was manager of the Hydraulics Division, Commercial Shearing & Stamping Company. Mr. Bergland will devote his attention to market and sales development.

Mr. Berglund

Woodall Industries, Inc., has moved to their new plant and office at 3500 Oakton St., Skokie, Ill.

Homer A. Goddard, Jr., has been named assistant general manager for industrial marketing for Gulf Oil Corporation. In his new post, Goddard will be responsible for direct sales to industrial plants and organizations.

Leo S. Ohman has been elected to the newly created position of vice president in charge of manufacturing for Hannifin Corporation, according to an announcement by Ellwood G. Peterson, president. The Hannifin firm, manufacturers of hydraulic and pneumatic equipment, also make a wide line of production equipment. Mr. Ohman has been factory manager for Hannifin since 1948 and has had a wide background in the instrument field as a specialist in factory material handling and production process control.

Mr. Ohman

Harvey E. Sloan, president and treasurer, Cushman Chuck Co., is celebrating the completion of 50 years service with the company. His father, Adrian P. Sloan, was one of the founders of the present organization.

Rivett Lathe & Grinder, Inc., Boston, Mass., announces the purchase of the entire line of Gerotor air and hydraulic valves, cylinders and hydraulic power units from Gerotor May Corp., Baltimore, Md. All manufacturing and selling operations are being transferred to Boston with no interruption in acceptance and delivery of orders. Rivett will offer all models in the line which will be marketed through the present Gerotor dealer organization. John A. Marsh, formerly special sales representative for Gerotor May Corp., has been named sales manager for the valve and cylinder division of Rivett Lathe & Grinder, Inc.

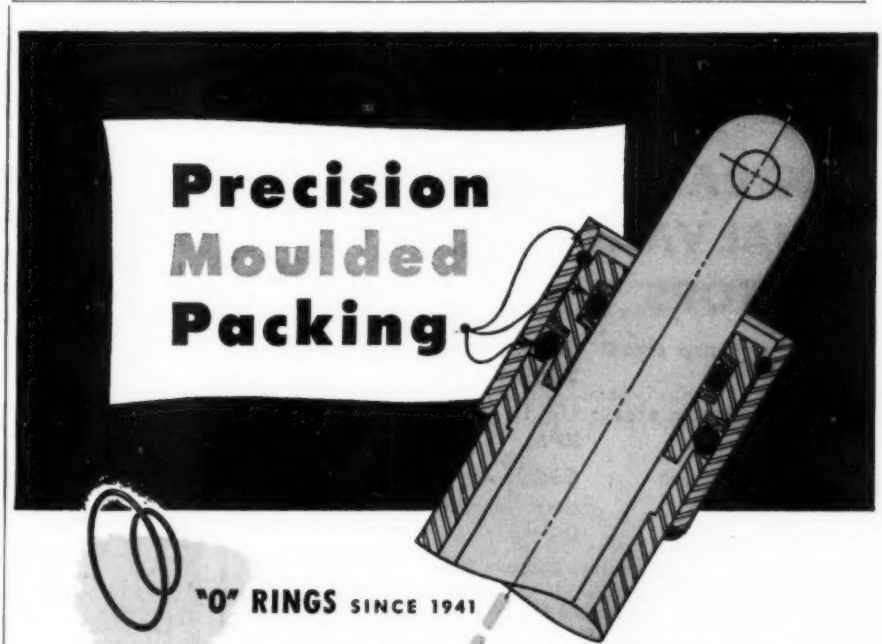
Gerotor May Corp. is retaining the manufacture and sale of Gerotor hydraulic pumps and fluid motors, which will be handled through the same dealer organization.

Opplem Company, 352 Fourth Ave., New York 10, N. Y., has been named sole sales and service agency for the Park Instrument Company.

R. G. Gehlsen has been appointed sales manager, Mines Equipment Division of Joy Manufacturing Co. At the same time the company announced the appointment of H. B. Zeppenfeld as manager, industrial sales, Mines Equipment Division.

John V. Eakin, formerly southwestern district manager, has been

(Continued on page 48)



Packings, Precision Moulded from the right compounds develop a nearly perfect hydraulic seal. Years of experience gained in making and developing these compounds is reflected in the final product.

From "0" rings to hydraulic accumulator bladders, Plastic and Rubber Products Co. *of Los Angeles* has for many years been successfully making precision packing for the hydraulic and pneumatic industries. The development of compounds of outstanding quality and performance are directly responsible for such success. Parco Balanced Compounds are used in all of our precision moulded packings. For "0" ring packing, investigate "0" rings from Parco Balanced Compounds. All dash numbers of both 6227 and 6230 series for commercial application or Army-Navy installations to Specification ANP 79 are available from stock.

Catalog and Engineering Data on request. Write:

Parco
Plastic & Rubber Products Co.
2100 Hyde Park Boulevard
LOS ANGELES 47, CALIFORNIA

(Continued from page 43)

new tests, the incendiary fire and spray flammability tests, were developed to evaluate the resistance of fluids to other hazards.

The relative flammabilities of a variety of fluids including petroleum oils, carboxylic and phosphate esters, glycols and derivatives, silicones, chlorinated and fluorinated compounds and water—all fluids were studied using these methods. It was concluded that the hydrocarbon and carboxylic ester fluids were quite flammable. Increasing the proportion of oxygen, phosphorus and halogen constituents and the concentration of water in a fluid composition reduced the flammability. The action of fire-resistant additives like volatile "snuffers" and non-volatile "quenchers" is imperfectly understood at present. It is important to understand the effect of high-boiling liquids in the hydraulic fluid range on elastomeres as such information will serve as a guide in research and development on new fluids and suitable packings.

It is concluded that only three hydraulic fluids which have been developed are sufficiently flame-resistant: Hydrolubes, the hexachlorobutadiene-base fluid "A" and the chlorinated aromatic base fluid "PS". Only Hydrolube can be used with the present packings. Hydrolube H-4 is now being further developed to improve the freezing point, V.I., and anti-wear properties. Both chlorinated fluids will require the development of new packing materials for hydraulic use, the problem for the chlorinated aromatic type presenting greater difficulties.

DUDCO'S EXTRA SMALL SERIES DUAL VANE PUMPS AND MOTORS

- **Pump sizes:** 3.5, 5, and 8 GPM for 2000 PSI Service
- **Motor sizes:** Up to 15 HP at 2000 RPM
- **Price:** $130.—again the best buy in the hydraulic field.

This new size completes Dudco's line of *continuous* duty hydraulic transmission Dual Vane Motors and Pumps. Single units are available up to 120 HP at 800 RPM for rugged reversing service where high stall torques are demanded.

DUDCO PUMPS AND MOTORS are used in mining machines, dry cleaning machines, oil derricks, conveyor drives, hydraulic presses, tapping machines, etc. where efficiency, ruggedness, and long life are at a premium; and oftentimes eliminates gear reduction units because of the motor SLOW SPEED-HIGH TORQUE capacity.

Engineering and application assistance is available from DUDCO'S Dealer ORGANIZATION located in most principal cities.

Send for literature of the DUDCO line of Pumps, Fluid Motors, and Power Units.

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Light toe pressure

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This compact "all-purpose" N.P. foot-operated valve for compressed air control is actuated without effort. Applies pressure with pedal up or pedal down, by simple arrangement of piping. Pedal is shielded for safety. No sticking . . . no air leaks . . . fast, trouble-proof operation. Write for Bulletin DC-203.

NATIONAL PNEUMATIC CO., INC.
Boston • Chicago
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NP

FOOT OPERATED CONTROL VALVE
FOR ALL TYPES OF AIR CYLINDERS

Six tables tabulate and compare the properties of the various hydraulic fluids tested with military specifications. A very complete bibliography is appended.

1949—Year Of Aviation Progress

Anonymous, *Technical Data Digest,* v 15, 1 January 1950, pp 9-10.

A review of outstanding achievements by the Department of Defense and its industrial contractors includes 16 new or highly improved warplanes, equipment and research facilities. Fighter planes included Republic's F-84E *Thunderjet* interceptor, the McDonnell's penetration fighter, the XF-90, Northrop's F-89 *Scorpion* night fighter and Consolidated-Vultee's subsonic delta-wing research plane, the XF-92A. Bombers include the B-36D, a new version of the *Flying Cigar* and Martin's XB-51. New cargo, attack and patrol bombers were delivered. New research facilities included the Navy's 5,000,000 lb capacity testing machine in the Philadelphia Navy Yard; the Air Force's new pilot plant at Adrian, Mich.; outfitting of the Seaplane Tender *USS Norton Sound* as a laboratory for firing of rockets and new wind tunnels built by North American Aviation, the University of California and the NACA for the Lewis Flight Propulsion Laboratory.

History Of Machine Hydraulics

H. G. Conway, *Machine Design,* v 21, December 1949, pp 120-121.

The second of a series—the article briefly reviews a few of the earliest types of reciprocating pumps.

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MICRONIC FILTERS

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AUTOMATIC SAFETY
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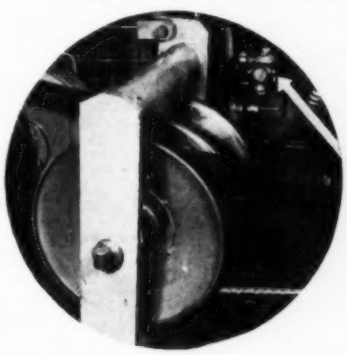
The DoALL Company, Des Plaines, Illinois has developed a most ingenious yet practical machine for contouring and shaping solids quickly and with elimination of chip waste.

Operational safety is provided in part by an ASCO 3-Way Solenoid Valve. It is used in the brake circuit and is open during machine operation allowing the oil to circulate. When the machine is turned off—or if a blade should break—the current to this solenoid valve is cut off which checks the flow of oil through the brake circuit, thus forcing the hydraulic oil into the brake cylinders which actuates the brakes and, in turn, stops the wheels.



So much in the way of automatic control—including remote control—with solenoid valves is being done that you should investigate them fully for controlling the flow of any gas or liquid in the machine you are designing. ASCO Engineers will be glad to recommend the proper type for your problem, as they have for hundreds of others. In writing, be as detailed as possible.

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